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THE TEAYS RIVER

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ABSTRACT

The course of the Teays River, a large Tertiary stream, including the present Kanawha and New Rivers and their tributaries, has been traced from its source in the Piedmont region, westward to the Illinois River. This stream, more than 800 miles long, crossed the entire Appalachian region, passing through the abandoned valley, from a point near St. Albans to Huntington, West Virginia. From Chillicothe, Ohio, the buried valley of the Teays has been traced, by means of well records, in a westerly direction across Ohio, Indiana and Illinois to the Mississippi. The Teays River was a mature stream and drained a maturely dissected region. An early glacier, Kansan or pre-Kansan, dammed its westerly course in Ohio, ponding the waters, forming lake-like expanses in southeastern Ohio. In the ponded areas, slack-water deposits were laid down. The broad valley of the Teays (Kanawha-New) River was an avenue for the migration of plant life from the Piedmont region to southeastern Ohio.

INTRODUCTION

W. C. Tight[1] was the first to discuss the drainage modifications of southeastern Ohio and to trace the course of the Kanawha River through the abandoned Teays valley in West Virginia to Chillicothe, Ohio, where it disappears beneath the glacial drift. The writer,[2] by means of well records, was able to trace the course of the buried Teays valley in a northwesterly direction from Chillicothe to St. Marys Reservoir in Mercer County, Ohio, and to the Indiana state line. The course, westward through Indiana was traced by Fidlar,[3] by means of well records, and roughly follows the Wabash River to its outlet. Horberg,[4] of the Illinois State Geological Survey, established the existence of a large buried valley which he named, "Mahomet River," extending westward from the Illinois-Indiana state line, through central Illinois and entering the well known bedrock valley along Illinois River, formerly occupied by the ancient Mississippi.

Fidlar[3] traces the preglacial Teays Valley through Fountain County, Indiana, some distance east of Wabash River, to join the present valley south of Covington.

Horberg[4] proposes an alternative hypotheses in which he suggests that the main valley turned west, near Lafayette, Indiana, through southern Benton County into Illinois, and as Mahomet Valley, continues westward to join the bedrock valley along the Illinois River. To support his view, he states that this valley

[1]Tight, W. G., Drainage Modifications in Southeastern Ohio and Adjacent Parts of West Virginia and Kentucky. Prof. Paper, No. 13, U. S. G. S., 1903.

[2]Ver Steeg, Karl, The Buried Topography of Western Ohio. Jour. of Geology, Vol. XLIV, No. 8, 1936, pp. 918–939.
———, Thickness of the Glacial Drift in Western Ohio. Jour. of Geol., Vol. XLVI, No. 4, 1938, pp. 654–659.

[3]Fidlar, M. M., The Preglacial Teays Valley in Indiana. Jour. of Geology, Vol. 51, 1943, pp. 411–418.

[4]Horberg, Leland, A Major Buried Valley in East-Central Illinois and its Regional Relationships. Manuscript read before Section E, Amer. Assoc. Advancement of Science, 1944.

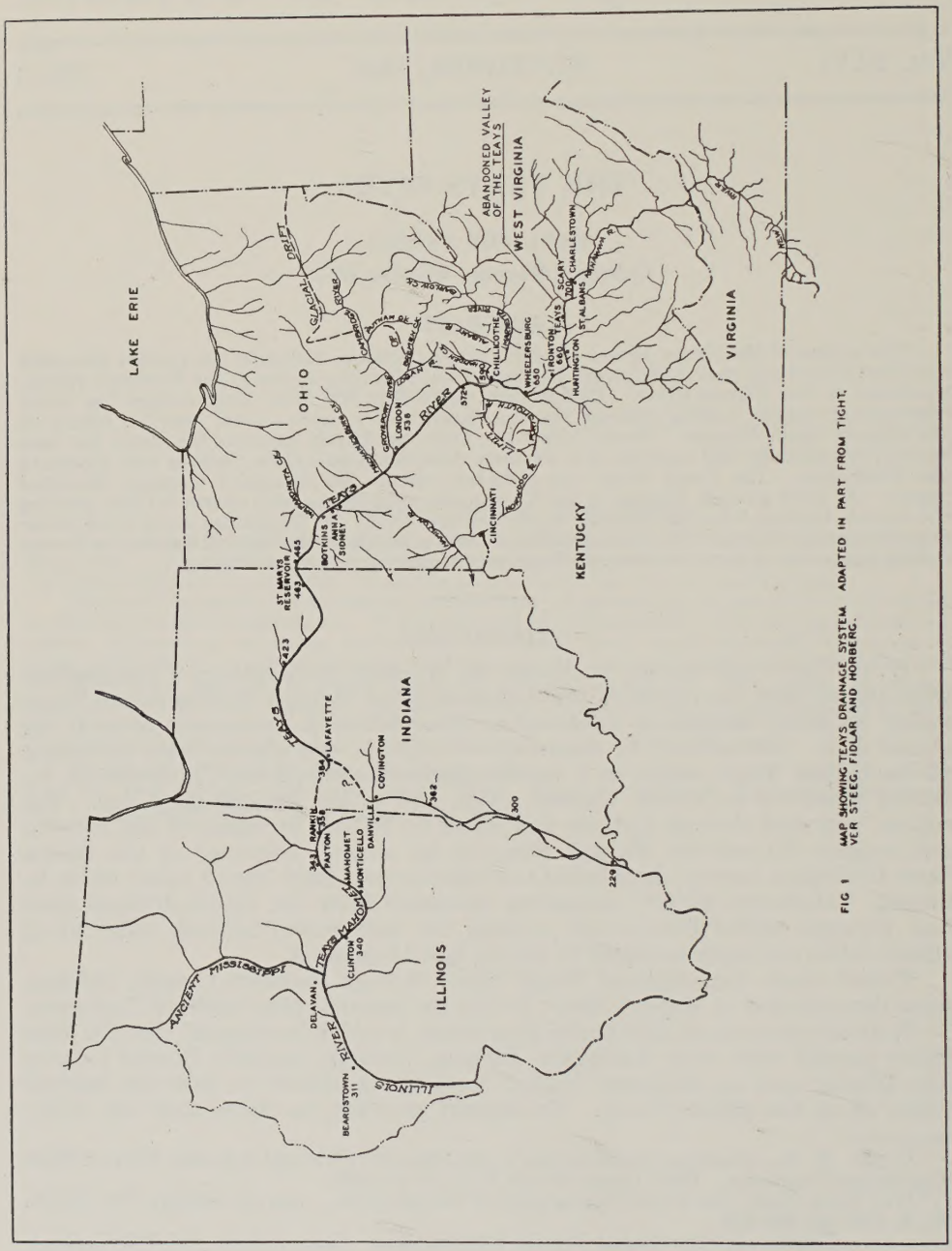

FIG 1 MAP SHOWING TEAYS DRAINAGE SYSTEM ADAPTED IN PART FROM TIGHT, VER STEEG, FIDLAR AND HORBERG.

in southern Benton County appears to be comparable in size to the one above Lafayette; bed rock elevations to the west are lower and more closely spaced than they are to the south, where there is an interval of about 90 miles before comparable low elevations are shown by Fidlar; this interval is an area of high bedrock, as indicated by well records and bedrock exposures. Furthermore, Horberg believes that the published evidence supporting the buried valley through Fountain County is inconclusive, and points out that Leverett in a discussion of the wells of Fountain County, in Indiana, makes no reference to an important buried valley within the county. Although the details of the buried drainage lines in the Lafayette region are not clear, the existing evidence strongly indicates that the main preglacial valley of the Teays continued into Illinois.

THE COURSE OF THE TEAYS

The name "Teays" was applied by Tight[5] to the stream which occupied the broad depression known as the Teays Valley, in Cabell and Putnam counties, West Virginia. In a general sense, the term is used to indicate the period of erosion in Ohio, before glaciation. The term is applied not only to the great stream and its tributaries, but to the work of all the streams contemporary with it.[6] The immaturely developed erosion surface associated with the Teays system is known in Ohio as the Parker Strath. The Teays River, the master stream of the system, was a large preglacial river and had its source near the eastern escarpment of the Blue Ridge, at the edge of the Piedmont Plateau in North Carolina and Virginia. The New River, the southernmost tributary of the Teays River, rises in Wautauga County in the Blue Ridge area, northeast of Asheville. From thence it flows in a northeasterly direction for some distance and after making a right-angled bend, it trends northward to join the Gauley River to form Kanawha River, which continues in a northwesterly direction to Charleston. In West Virginia, the Teays received the waters of the Greenbriar River, Gauley River, Elk River and numerous minor tributaries, including a drainage area of the entire southern half of the state. In its course, the Teays River cut across the folded Appalachians, a remarkable feature which calls for an explanation as to the origin of its drainage. In addition to the waters of the New-Kanawha system, the Teays River received the major portion of the drainage from an area including one-half to two-thirds of Ohio and a large part of Indiana, Illinois and northern Kentucky. The Teays River, after passing through the abandoned valley, from a point near St. Albans to Huntington, West Virginia, extended across Ohio in a northwesterly direction; its valley buried beneath the glacial drift, continues from Chillicothe to the border of Indiana, near St. Marys Reservoir. From there, its course is westward[7] across northern Indiana to the eastern border of Illinois,[8] where it continues in a westerly direction across that state, into the bedrock valley of the Illinois River. This great stream, one of the largest of Tertiary time, was at least 800 miles long and probably longer, depending upon what evidence one accepts as to its course in Indiana and Illinois.

The significance of the abandoned Teays Valley from St. Albans, West Virginia, to Chillicothe, Ohio, and its relationship to the preglacial drainage in Ohio, was first determined by Tight.[9] This valley varies in width, from three-quarters to one and one-quarter miles, an average of a mile being about correct; its length is about 30 miles from St. Albans to Huntington. No doubt, a large stream once occupied this abandoned valley. Tight includes Flatwoods Valley, from Ashland

[5] *Idem.* 1.
[6] Stout, Ver Steeg and Lamb, Water in Ohio. Bulletin 44, Geol. Surv. Ohio, 1943, p. 51.
[7] *Idem.*, 3, pp. 411–418.
[8] *Idem.*, 4.
[9] *Idem.*, 1.

to Ironton, as an extension of the Teays Valley. From Huntington to Wheelersburg, the present Ohio River, which occupies this portion of the old Teays Valley, did not obliterate all traces of the former occupant, as the floor of the original valley is indicated by the extensive silted flats south of Ashland and the terraces between Franklin Furnace and Wheelersburg on the Ohio side.

At Wheelersburg, the Teays River flowed northward past Minford, Stockdale and Beaver, to Waverly, through a high-level, broad, well-defined open valley. The Scioto River has eroded and partially destroyed the Teays Valley from Waverly to Richmondale, but its floor exists as broad upland flats, near Omega and Higby. The Teays continued northward to Chillicothe, where the old valley disappears beneath a thick covering of Wisconsin drift.

From Chillicothe, the course of the buried Teays Valley, is based on well records plotted by the writer.[10] These are shown on the map (Fig. 2), and include the minimum, maximum and average depth to bedrock. Some of the wells do not reach bedrock and are indicated on the map by the letter "G." From Chillicothe, the Teays Valley can be traced in a northwesterly direction past Andersonville, crossing the southwestern part of Pickaway County, past Atlanta. From there, it crosses the extreme northeast corner of Fayette County near Waterloo, extending in a northwesterly direction past London in Madison County, to Vienna in Clark County, where the Teays was joined by a tributary, the Groveport River,[11] which drained a large area in central Ohio. From Vienna, the Teays River continues in a westerly direction, to a point near Springfield, in Clark County, and thence northwestward past Boulusville and St. Paris in Champaign County, and Sidney, Anna and Botkins, in Shelby County, to the southeastern part of Washington Township in Auglaize County, where it was joined from the north by a tributary, Wapakoneta Creek. The Teays continued its course westward past the village of Mercer to Rockford, and from there, westward to the Ohio-Indiana state line, in the northwestern part of Rock Creek Township, in Mercer County.

TRIBUTARIES OF THE TEAYS RIVER

The tributaries of the Teays, in the unglaciated area beyond the drift border in southern Ohio, exhibit the same characteristics shown by the master stream; the adjacent hills are considerably reduced, the tributaries have low gradients, broad valleys for the size of the streams which occupied them, and dendritic pattern, all features of maturity. The largest of the tributaries in Ohio[12] are the Marietta River, Hamden Creek, Albany River, Barlow Creek, Portsmouth River, Logan River, Bremen Creek, Putnam Creek, Cambridge River, Groveport River, Mechanicsburg Creek, and Wapakoneta Creek.

In his paper[13] on the Teays River in Indiana, Fidlar mentions a number of tributaries which have been partially traced. From the size of these streams, it appears that the Teays River drained a large area in northern and central Indiana. Horberg,[14] who traced the Teays River across Illinois, shows a tributary from the north which entered the Mahomet Valley near Paxton, and important tributaries from the south, north of Danville, and in western Logan and Menard counties. Tight[15] shows a tributary, called the Cincinnati River, flowing northeastward from the southwest corner of Ohio, to Dayton, to join the Teays River. There is evidence[16] that the drainage in the Miami basin, just before the advent of the ice age,

[10] *Idem.*, 2.
[11] *Idem.*, 6, Map of Teays Drainage, p. 50.
[12] *Idem.*, 6, pp. 57–70.
[13] *Idem.*, 3, pp. 412, 413, 416, 417.
[14] *Idem.*, 4.
[15] *Idem.*, plate I.
[16] *Idem.*, 2, p. 927.

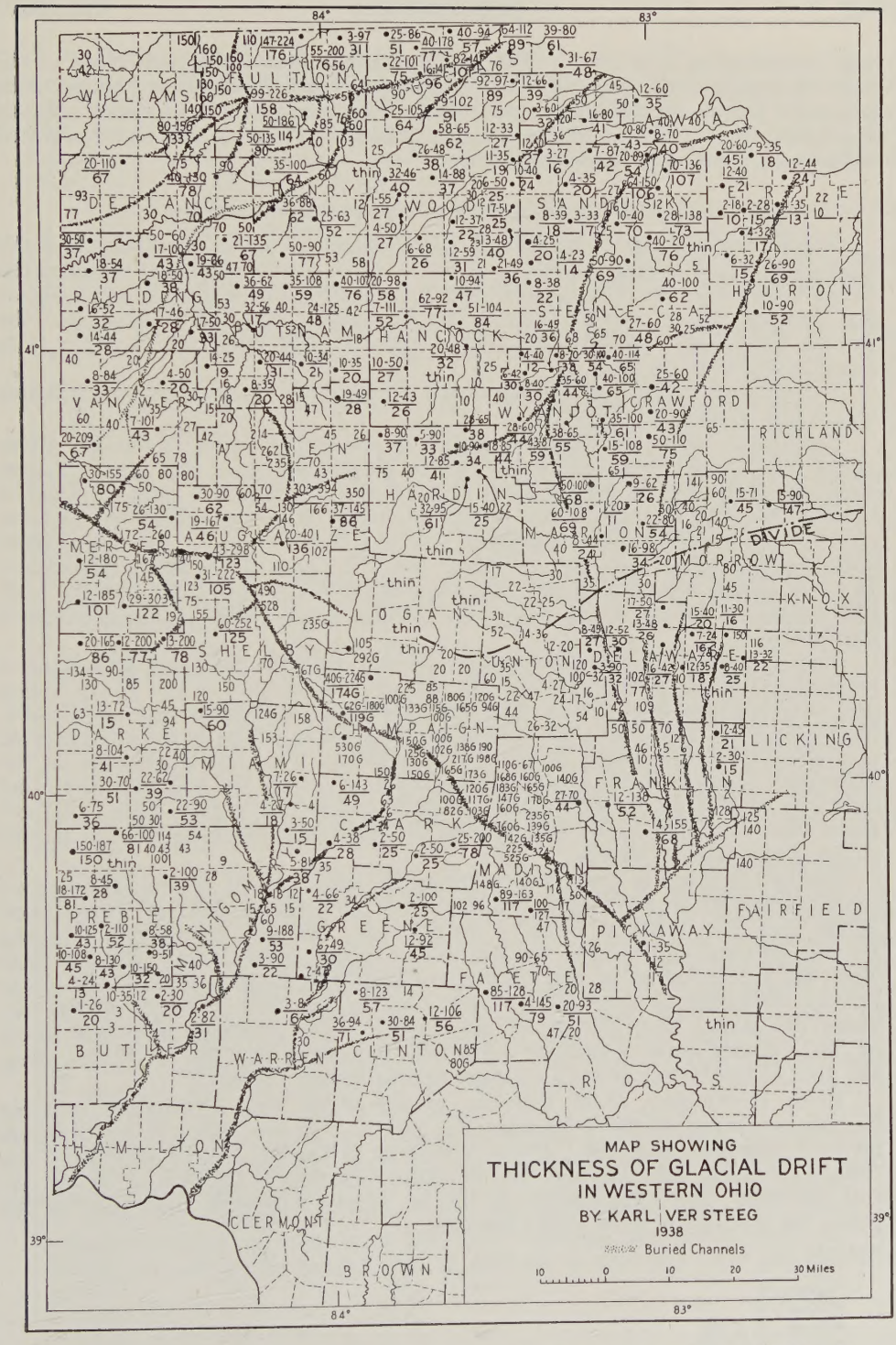

Fig. 2. Map showing the buried valley of the Teays River and other streams in Ohio. Figures above the line indicate minimum and maximum thicknesses. Figure below the line represents the average thickness. The letter "G" indicates that bedrock was not reached.

was southward as it is today. This evidence is based on the general slope of the bedrock surface in the Miami basin. It appears that a divide existed between the preglacial Teays and the Miami watershed. Well records do not indicate a broad depression which widens northward and is of sufficient size to have accommodated so large a stream as the Cincinnati River.

STAGE OF DEVELOPMENT IN THE CYCLE OF EROSION

The Kanawha Valley at St. Albans, West Virginia, is about the same size as the Teays Valley; an average width of about a mile. The stream that occupied the Teays Valley from St. Albans to Wheelersburg, Ohio, was nearly the same size as the Kanawha River near St. Albans and Charleston, which is smaller than the present Ohio River. The buried Teays Valley in Ohio may have a width of as much as five miles, in places.

Fidlar[17] does not give the width of the Teays Valley in Indiana but indicates that it is a broad depression.

Homberg[18] states that the inner portion of the buried Teays (Mahomet) River valley lying below elevations of 450 feet, is about four miles wide near the east state line, five miles in central Piatt County and about fifteen miles in DeWitt County; although the valley walls cannot be sharply drawn in most places because of the lack of detailed data, a notable widening is indicated for the downstream portion of the valley. He also indicates[19] that the valley of the Teays (Mahomet) River in Illinois was mature and cites the relative width and depth and the wide distribution of low elevations in DeWitt County, which suggest the presence of a floodplain.

Tight[20] believed that beginning with the old Tertiary peneplain as a base, a very long cycle of erosion produced the topographic features of the Teays Valley and its well-graded floor, which must have stood near base-level for a considerable length of time. Although there is little evidence for the stage in the erosion cycle of the buried Teays Valley in Ohio, it is assumed, from the appearance of the abandoned valley from St. Albans to Chillicothe, and from the width of the buried valley as determined by well records, that it was in the mature stage. Fidlar[21] states that the Teays Valley had reached the stage of maturity before the advent of the Pleistocene ice sheets.

The bed rock of the Teays Valley has an altitude of about 700 feet at Scary on the Kanawha River; 660 feet at Huntington, West Virginia; 650 feet on Dogwood Ridge near Wheelersburg, Scioto County, Ohio; 645 feet near Glade, Jackson County; 640 feet near Givins, and 630 feet at Omega, Pike County; 610 feet near Vigo, 592 feet at Schooleys, and 590 feet at Chillicothe, Ross County; 572 feet near Atlanta, Pickaway County; 530 feet near London, Madison County; and 465 feet under St. Marys Reservoir in Mercer County. The gradients and floor levels of the tributary streams conform quite well, indicating that the elevations along the floor of the buried Teays Valley are approximately correct.[22]

From Huntington, West Virginia, to Schooleys, near Chillicothe in Ross County, a distance of about 90 miles, the rock floor of the Teays Valley descends about 9 inches to the mile. From Schooleys to the St. Marys Reservoir, the distance is about 133 miles and the fall of the rock floor is 132 feet, or nearly one foot per mile. From Huntington to the St. Marys Reservoir, a distance of 233 miles, the gradient is 10.76 inches per mile.

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[17] *Idem.*, 3.
[18] *Idem.*, 4.
[19] *Idem.*, 4.
[20] *Idem.*, 1, p. 56.
[21] *Idem.*, 3, p. 412.
[22] *Idem.*, 6, p. 53.

The bedrock elevations along the Teays Valley in Indiana, according to Fidlar,[23] are as follows: Jay County, 463 feet; Miami County, 423 feet; Lafayette, Indiana, 384 feet; Oxford, Benton County, 300 feet. According to Fidlar,[24] the Teays Valley in Indiana, had a gradient of approximately 8 inches per mile; the bedrock floor drops from an altitude of 463 feet in northwestern Jay County, to an altitude of 229 feet in southwestern Posey County.

In Illinois, the elevations along the floor of Teays (Mahomet) Valley, according to Horberg,[25] are as follows: Rankin, Vermilion County, 358 feet; Paxton, Ford County, 343 feet; Clinton, DeWitt County, 340 feet; Beardstown, Cass County, 311 feet. This is a fall of 47 feet. A gradient of 7 inches per mile is indicated for that portion of the Teays above Beardstown, Illinois.

From all the evidence, such as the great width and low gradient of the Teays Valley, and the bordering hills, which are well-rounded and graded, one would assume that it was in the mature stage of the cycle of erosion. Everywhere, in West Virginia, central and southern Ohio, the adjacent hills were reduced and the land highly dissected in dendritic pattern. In preglacial time, in western Ohio, on the easily eroded shales and limestones which were peneplaned, the valleys in the Teays stage were broad, such as would exist in a region worn down to an advanced stage of erosion. From North Carolina to Chillicothe, Ohio, the New-Kanawha River is entrenched below an extensive erosion surface which is known as the Harrisburg peneplane. The erosion level, known as the Parker Strath and also as the Teays surface, is younger and does not appear to be developed to any great extent in the Allegheny Plateau province in Pennsylvania and West Virginia. What surface it is correlated with, in the folded Appalachians, is not determined. The Parker Strath represents the immature peneplane or partially developed base-level evolved in Teays time. This erosion surface should be more extensively developed in western Ohio on the widespread, weaker limestones and shales of Silurian and Devonian time. Furthermore, the vertical distance the streams had to cut down to reach grade or base-level, was less than farther east in the Allegheny Plateau area, where harder Mississippian and Pennsylvanian sandstones and conglomerates stand higher and offer more resistance to erosion. The original slope of the Appalachian Plateau was toward the east as it is today, and the first streams probably worked headward from the west and northwest.

In Ohio, the buried Teays Valley is entrenched below an upland surface. At the London Prison Farm, located northwest of London, in Madison County, Ohio, one well record shows that the drill penetrated 525 feet into glacial material and did not reach bedrock. A short distance to the east, another well record shows a depth of only 324 feet to bedrock. Here, the wall of the buried valley is steep and makes a sharp break with the old surface. A study of the well records indicates a deep valley (Fig. 2), comparatively narrow in places, with rather steep sides. In Shelby County, near the town of Anna, a deep, narrow valley is indicated by well records, showing more than 500 feet of glacial drift. To the east and west of this channel, the elevation of the bedrock is about 800–900 feet. A deep, and comparatively narrow valley is indicated by the well records in Mercer County at St. Marys Reservoir, the surface bordering the trough standing at 700–800 feet.

Fidlar[26] states, that in Indiana the well records show that the bedrock surface slopes gradually toward the Teays Valley, and that this slope becomes abrupt at the site of the rock trough. He points out, that near central Blackford County, the bedrock surface drops more than 250 feet in less than one-fourth of a mile. The bedrock upland in this vicinity has an altitude of approximately 800 feet above

[23] *Idem.*, 3.
[24] *Idem.*, 3, Abstract, p. 411.
[25] *Idem.*, 4.
[26] *Idem.*, 3, p. 415.

sea-level and the valley floor is at least 350 feet lower. Fidlar's figures on the depth of the Teays Valley do not indicate that it is shallow with gently sloping sides. In Illinois,[27] the bedrock elevations along the buried valley are less than 400 feet above sea-level, or 200 to 300 feet lower than the elevations on the adjoining bedrock uplands. Its average depth is given as about 200 feet. According to Horberg,[28] there is a suggestion that the Teays Valley, in Illinois, may have been eroded during two cycles, as the inner valley is entrenched below a broad, outer valley. This is indicated by the pronounced break in slope below the 550–500 foot contours and by the absence of comparable low elevations outside the inner valley. The Teays Valley becomes broader to the west, which is as one would expect. It appears that the buried preglacial bedrock surface on the uplands along the Teays in Ohio and Indiana, is the equivalent of the same buried surface in western Ohio, which is believed by some geologists to be the same as the Parker Strath. This surface was developed in late Tertiary time and has been called the Teays erosion surface,[29] since it was developed along that preglacial stream and its larger tributaries, just before the advent of the Pleistocene ice-sheets.

The most striking features of the topography of the area drained by the Teays River, from its source and across the folded Appalachians, through the Allegheny Plateau and southeastern and central Ohio, are the upland peneplane, the mature valleys of the old cycle, the deeply cut trenches of the present drainage, and the terrace fillings in the bottoms of those trenches. A summary of the events which took place in southeastern Ohio are: (1) the reduction of the region to the base-level of the early Tertiary peneplane (Harrisburg); (2) the elevation of the early Tertiary peneplane and the rejuvenation of the mature drainage, with the entrenchment of the streams in deep valleys, which retain the meanders of the ancestral streams; (3) the gradation of the drainage, with the development of mature topographic features and the reduction of the upland peneplane (Harrisburg), with the development of dendritic drainage; (4) slack-water conditions, produced by the Kansan or pre-Kansan ice-sheet, with the widespread deposition of silts up to the present elevation of 860 feet and to a depth of as much as 80 feet or more in places, and many deflections of drainage from the old lines; (5) rejuvenation and deep erosion of the new lines of drainage below the level of the old system. This period of erosion is known as the Deep Stage[30] and is interglacial, beginning with the Kansan or pre-Kansan ice-sheet and closing with the advent of the Illinoian glacier; (6) interruption of the Deep Stage and the filling of the valleys with Illinoian till, glacial gravel trains and silts; (7) the erosion of the valley fillings and the cutting of the intermediate terraces to the depths of the present streams; (8) Wisconsin glaciation and filling of the valleys with till and outwash; (9) the reduction of the volume of the streams and continued stream action to the present time under existing conditions. From the inauguration of the Kansan or pre-Kansan ice-sheet, the Teays drainage system in Ohio was tremendously changed, during the advance and retreat of the Illinoian and Wisconsin glaciers.

CORRELATION OF EROSION SURFACES IN ILLINOIS

According to Horberg,[31] a preliminary study of the erosion surfaces in Illinois suggests that the Teays (Mahomet) Valley is entrenched below the level of a surface which is probably younger than the Dodgeville or southwestern Wisconsin. In the Havana region, the inner valley of the buried Teays (Mahomet) River appears to be eroded below the level of a still younger strath, which is about 500

[27] *Idem.*, 4.
[28] *Idem.*, 4.
[29] *Idem.*, 6, p. 51.
[30] *Idem.*, 6, p. 78.
[31] Horberg, Leland, Communication by letter.

feet above sea-level. Similar straths are present in the Kaskaskie and Wabash basins. Horberg finds no evidence of important bedrock erosions during the Yarmouth interglacial epoch, which would correlate with the Deep Stage in Ohio. He believes Mahomet Valley was eroded to its maximum depth in pre-Kansan and probably pre-Nebraskan time. He points out that the strath in central Illinois occupies a position similar to the Parker in Ohio. He suggests that perhaps the pre-Kansan entrenchment did not reach headward as far as Ohio.

PONDING OF THE TEAYS RIVER

From Franklin Furnace, in Scioto County, to Chillicothe, in Ross County, Ohio, parts of the old Teays Valley show good exposures of silts; sandy silts near bedrock and very finely laminated Minford silts at the higher levels. The materials that may be present in the deposits are coarse matter, fine-grained sand, siliceous and ferruginous silts, very fine-grained laminated silts and heterogeneous outwash from side streams. A study of the deposits in the Teays Valley and its tributaries indicates that some material must have come from the metamorphic and igneous rocks as far east as the Piedmont Plateau. These deposits also occur in the abandoned valley of the Teays from Scary to Huntington, West Virginia.[32] It is believed[33] that the advance of the Kansan or pre-Kansan ice-sheet to central Ohio blocked the westward course of the Teays River and other streams flowing northward, causing them to seek new outlets south of the edge of the ice. The drainage was considerably modified and long, marginal finger lakes were formed in which were deposited the slack-water Minford silts. They were deposited in rather deep quiet waters which were ponded to lake-like conditions throughout the valleys. The ponded water must have existed for a long time, sufficient for at least 80 feet of silt and sand to accumulate. This silt filled the valleys to a level not far from 900 feet. The ponded area was of great size and although its southern and southwestern boundaries at the time of its maximum depth are not clear, it probably extended as far west as the Licking Valley of Kentucky, as far east as the present Kanawha River in West Virginia, as far north as northern Ross and Athens counties, and 40 to 50 miles south of the present Ohio River. In Kentucky, a number of glacial boulders of large size and Canadian origin have been discovered by geologists above an altitude of 900 feet, and more than 50 miles south of the known glacial boundary. One glacial boulder, estimated to weigh about 16 tons[34] lies at an elevation of 1009.3 feet. Because this altitude is well above the 900-foot level, which is believed to be the approximate elevation of the ponded water, geologists have been puzzled as to how this huge erratic could have been laid down at its present level, even though it was rafted by an iceberg. It might be assumed that the level of the water may have fluctuated in elevation, and under certain conditions an iceberg or mass of floating ice may have reached that altitude. All the silt deposits are at, or below, a level of 860 feet. The waters which fed the ponded area was drainage from the plateau and melt-water from the Kansan or pre-Kansan ice-sheet, located to the north. Such a marginal lake must have been subject to fluctuations in water level, because of the floods due to heavy rainfall and melting snows on the plateau, as well as rapid melting of the ice-sheet. The great accumulation of slack-water deposits, to a level of 860 feet, buried the old preglacial valleys and underlying topography. When the lake was drained, many of the streams did not return to their former courses. New outlets were opened to the Ohio River. These streams followed old drainage lines where they still

[32]Stout, Wilber, and Schaaf, Downs; Bulletin Geological Society of America, Vol. 42, pp. 665–666, 1931.

[33]*Idem.*, 6, p. 78.

[34]Jillson, W. R., The Early Pleistocene Glaciation in Northeastern Kentucky. Bulletin Geological Society of America, 50, 1931.

existed, and cut new channels at many places. The ponding of the valleys in front of the Kansan or pre-Kansan ice-sheet caused considerable disarrangement of the preglacial drainage lines. Through obliteration of the lower courses of the Teays streams by glacial action and through flooding of the remaining parts of the courses, new drainage lines were established by the ponded waters seeking new outlets to the sea. These new streams are known as the Deep Stage drainage of post-Kansan or post pre-Kansan age. They cut youthful valleys below the Teays drainage level.

The major events in the drainage changes as put forth in part by Tight[35] and later, with modifications by Stout, Ver Steeg, and Lamb,[36] are as follows: The first event was the advent of the Kansan or pre-Kansan ice-sheet, which blocked the streams which flowed in a northwesterly and northward direction. This resulted in the formation of a large stretch of ponded water in the valleys of the Teays River and its tributaries, in Ohio and West Virginia, and the Licking River system in Kentucky. Thick accumulations of slack-water silts were deposited in this lake-like body of water. This resulted in the development of new outlets, modification and reversal of drainage. Later events include the advances of the Illinoian and Wisconsin ice-sheets and the modification of the silts, sands and clays. In pre-Illinoian time, during the interglacial epoch, known as the Deep Stage, the Ohio River and its tributaries cut their valleys to greater depth. Subsequently, interglacial and present day streams produced terraces by erosion of the slack-water filling in the valleys.

THE TEAYS VALLEY AS AN AVENUE FOR PLANT MIGRATION

Transeau[37] points out that the ponding in southern Ohio would have a profound effect on the vegetation of the area covered by the silts. The submerged vegetation would be destroyed and there was a complete change in the soils, to which plants that survived on islands and peninsulas may have subsequently migrated. When the streams flowed northward, in preglacial time, the soils of the submerged area were derived from the sandstones and shales of the plateau. When the ponding took place, the streams from the glaciers carried calcium and magnesium carbonates from the limestone area of central and northern Ohio. It was not until the silts were removed by erosion, that many of the plant habitats were removed and developed their present characteristics. Transeau believed that there are many localities in southern Ohio where, for example, the rhododendron might be expected to grow but in which it is absent. According to Wolfe,[38] southern plants reached Ohio along the hilltops and ridges of the Cumberland Plateau, across the route of the present Ohio River, and by way of the flood plains and adjacent bluffs of the preglacial Teays River system, the headwaters of which reached far to the southeast into western North Carolina. It is believed that the Teays and other rivers with headwaters in the Appalachians have been effective agencies of migration and it is probable that many southeastern species of plants were living in the plateau section of Ohio before the advent of the ice in Pleistocene time. Wolfe[39] points out that a large number of isolated Appalachian and southern species of plants are known in the southern Ohio area. Their arrival, isolation in well-defined areas, and their persistence, are doubtless associated with the succession of events in the physiographic history of the region.

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[35] *Idem.*, 1.

[36] *Idem.*, 6, pp. 51–106.

[37] Transeau, Edgar Allen, Prehistoric Factors in the Development of the Vegetation of Ohio. Ohio Journal of Science, Vol. XLI, No. 3, May, 1941, pp. 207–211.

[38] Wolfe, John N., Species Isolation and a Preglacial Lake in Southern Ohio. Ohio Journal of Science, Vol. XLII, No. 1, Jan. 1942, pp. 2–12.

[39] *Idem.*, 38.

ORIGIN OF THE TEAYS (KANAWHA-NEW) RIVER

The upper section of the Kanawha is known as the New River and its headwaters may be said to be almost on the Atlantic slope, for they lie on the southeastern side of the Blue Ridge Mountains in North Carolina. Tight[40] mentions the Kanawha River as being antecedent to the Appalachian uplift. The slope of the ridges and hilltops in the Appalachian province, toward the Kanawha-New River, indicates that the Schooley and Harrisburg surfaces had a marked inclination toward the trunk stream and its major tributaries. The broad sags on the ridge crests throughout the Appalachians, below which the major streams have cut their gaps, represent the old valleys on the Schooley surface. It is evident that the courses of the major streams in the Appalachians, including the Kanawha-New, were established during or before the Schooley cycle. It appears to be impossible for the streams in the folded Appalachians to have been superposed on the Schooley penoplane, a surface of considerable relief.[41] The Delaware, Susquehanna, Schuylkill, Lehigh and Potomac rivers cross hardrock ridges in their course eastward to the Atlantic. One of the theories for the origin of the courses of these streams has been explained by regional superposition on an extended coastal plain cover[42] over a peneplane earlier than the Schooley.

The Kanawha-New River, a major stream, crosses the entire folded Appalachian belt. Its course is one of the most remarkable in the Appalachian region. In all the discussions concerning superposition in the Appalachians, little has been written as to the origin of the Kanawha-New drainage across the ridges. For one to explain the courses of the major eastward-flowing rivers in the Appalachians as inherited from a superposed cover, and attempt to use another explanation for the Kanawha-New drainage, violates all principles of logical reasoning. One must be consistent and admit that if the eastward-flowing streams in the folded Appalachians were superposed, the Kanawha-New River, in the same general area, doubtless had the same physiographic history. Johnson[43] suggests that southeast-flowing master streams of the Appalachian slope, inherited their courses from a coastal plain cover which reposed upon a peneplaned surface of pre-Schooley age and which formerly extended, in some places at least, from 125 to 200 miles northwest of the present innermargin of the coastal plain deposits.

The depth and width of the buried Teays valley in Illinois, Indiana and Ohio appear to indicate a large and old stream. Its lower course must date back far into pre-Tertiary time. Since the Teays (Kanawha-New) River is entrenched below the Schooley and Harrisburg surfaces in the folded Appalachians and Appalachians and Allegheny Plateau, one would assume that an enormous amount of erosion had taken place since its original course was established. The broad sags on the ridge crests below which the stream has cut its gaps, would appear to indicate that the Teays (Kanawha-New) River existed in the Schooley cycle and perhaps earlier. Wright[44] calls attention to the fact that it is difficult to explain the westward course of the Teays (Kanawha-New) River on the Piedmont Plateau, beveled by the Harrisburg peneplane, which apparently sloped eastward. There are many unsolved problems concerning the origin of the drainage in the Appalachian region and any general consideration of such drainage problems should include the history of the Teays River, one of the largest and longest streams in the Appalachians. The course of the Tennessee across the Appalachian ridges and Cumberland Plateau also merits the same consideration. Undoubtedly, the history of all the streams in the folded Appalachians is closely related to the same general causes.

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[40] *Idem.*, i, p. 15.
[41] Ver Steeg, Karl, Annals New York Academy of Science, Vol. XXXII, pp. 87–220.
[42] Johnson, Douglas, Stream Sculpture on the Atlantic Slope. Col. Univ. Press.
[43] *Idem.*, 42, p. 133.
[44] Wright, Frank, Communication.

VARIATIONS IN THE BIRD POPULATION OF OHIO AND NEARBY STATES

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The area where most of our observations on the abundance of birds have been made includes Toledo, Bowling Green, and Sandusky, Ohio, extending 25 or 30 miles from each of these cities. In many of the species mentioned here we have evidence that similar changes have taken place over a much wider area, including northern Illinois, southern Michigan, and the western parts of New York and Pennsylvania.

EFFECT OF MODERATING CLIMATE

Temperature records in the northern states show that the average in recent years has been higher than the long time average; in other words, the climate has been moderating. How long this will continue we do not know.

At Chicago the normal or long-time average is 48.4°. In the last 18 years the annual temperature has been lower than this only once, and in the 51 years following 1893 only 8 times, but in the 33 years, 1845–1877, the annual temperature was below 48.4° twenty-two times.

At Cleveland the normal is 49.6°. Only four of the 27 years since 1917 have had a lower annual temperature.

In Ohio, taken as a whole, annual temperatures were below normal only seven times in the 25 years following 1917. In Indiana they were below the normal of 52.7° nine times in the 26 years, 1919–1944. "At Indianapolis February temperatures, 1916–1935, averaged 4° warmer than those for 1896–1915. Between February 19, 1936, and January 2, 1940, reliable thermometers did not reach zero at all; this was the first such long period without any zero weather in that city since the U. S. Weather Bureau was established." (S. S. Visher, Climate of Indiana, 1944, p. 358.)

Glaciers afford a means of knowing climatic trends for much more than one century. A period of years with more than average snowfall, and temperatures below normal, causes the ice to accumulate and move down the valley faster than it melts away, so that the ice front extends farther down than previously. When the weather becomes warmer and less snow falls the ice front retreats.

During most of the time for more than half a century glacial fronts have been retreating in all parts of the world where glaciers have been studied. On the North American Continent they are found only in the western part and little study of their motion was made until the latter part of the nineteenth century. John Muir wrote, "All glaciers that have come under my observation in southeastern Alaska have retreated and shallowed since first I became acquainted with them in 1879 and 1880."

In western Canada, Montana, and the Pacific states as far south as southern California, very few of the glaciers show evidence of advances in recent decades. Nearly all of those whose fronts have been surveyed show retreat and the rate of retreat has recently shown a marked acceleration.

In the United States "the annual losses of ice have been much greater during the 1920's and 1930's than during the decades immediately preceding. Three small glaciers in Oregon and several in California have entirely melted away in the past 25 years and those in Glacier National Park and in Montana are wasting

away at a rate which, if continued, will result in their total extinction within the next few decades." (Francois E. Matthes, Hydrology, 1942, pp. 195 and 196.)

Since the Wisconsin ice sheet started its retreat from its southern limit south of Dayton, Ohio, something like forty or fifty thousand years ago, there have been periods when both the continental glaciers and the mountain glaciers readvanced and covered again parts of the land which had been freed from its burden of ice.

Studies by botanists of the pollen in peat bogs in Ohio, Indiana, Sweden, and other parts of North America and Europe have confirmed and supplemented conclusions based on the study of glaciers. Fir, spruce, and many species of pine can stand more cold than hickory, oak, and maple. Microscopic examination of the pollen in successive layers of the vegetable matter in these bogs makes it possible to infer what changes of climate have taken place.

For thousands of years after the continental ice sheet had disappeared from the northern states the climate was milder than it is now. About 2000 B. C. conifers began to crowd back southward the deciduous trees which had long thrived in the mild climate. This cool period continued, with numerous brief interruptions, until about 1600 A. D. Then it became still colder; glaciers in Switzerland overran villages and land where forests had been growing for centuries. When our ancestors first landed in New England and New York they encountered a more rigorous climate than had prevailed there in previous centuries. In the 1850's it became much warmer and there was a rapid retreat of glaciers. Since then it has been cooler for a few years at a time, but not so cool as in the seventeenth and eighteenth centuries. During most of the past quarter century the weather has been rather mild.

Records of temperatures have been kept at a few places in the eastern part of the United States since early in the nineteenth century. Those at The Marine Hospital, Ft. Columbus, New York City, cover the period 1822–1874. In the first eight years of this record the average temperature was higher than in any decade that followed. The U. S. Weather Bureau records at New York started in 1871. They show that in that city annual temperatures continued below normal in most of the years to 1897. After that a majority of them were above normal. Likewise, in the North Central States relatively cool weather prevailed until sometime in the 1890's.

At New York City the warmest of all the decades was 1930–1939, with an average of 53.7°. In 1830–1839 the average was 2.9° lower, that is 50.8°. This corresponds fairly well with the rate of change at Cleveland where the average, 51.38°, for the period 1931–1942 was 2.13° higher than the average of 49.25° in 1856–1870. In both of these records I have made due allowance for the difference in location of thermometers. The record of Gustavus A. Hyde at Cleveland extends from 1856–1906, and so overlaps that of the Weather Bureau for many years, giving a good basis for comparison. His instruments were furnished by the Smithsonian Institution.

The range in annual temperatures is much larger than that of decades—seven or eight degrees at places with long records.

Changes of climate such as these might have little effect on the bird population in a region where nearly all of the winters are mild, but the area whose bird population we are considering lies mainly between the 40th and 43rd parallels. Throughout the greater part of it the mean temperature from mid-November to mid-March is not very far from 32°. In those winters when it is three or four degrees lower than 32° snow may be expected to cover the ground during a much larger part of the time than in those winters when it is a few degrees above 32°.

We have records of the amount of snowfall at many places since early in this century or the latter part of the nineteenth century.

Of the twenty-six years since 1918, nineteen have had less snow than the long

time average in Ohio and twenty had less in Indiana. In nine of the seventeen that were below average at Toledo the amount of snow ranged from 12.2 inches to 21.1 inches; the average, 1885–1942, was 30.4 inches.

In the winters, 1885–1886 to 1917–1918, snowfall was above average at Toledo 22 times, that is, in two-thirds of the whole number. In each of eight of these winters more than 40 inches of snow fell. In the winter of 1895–1896 there was five times as much as in the winter of 1918–1919.

In some periods of a decade or two most of the years have had average monthly temperatures in the two coldest months several degrees below 29°; in other periods of similar length a majority have had averages a few degrees above 29°. Such differences affect our fuel bills to the extent of 25% or so.

The fuel on which a bird depends is the food it eats. When the food is cold, some calories are lost in warming it. A few degrees would not amount to very much were it not for the latent heat in unfrozen food and the lack of it in that which must be thawed out inside of the bird. A large part of the food of birds yields less than 700 calories per kilogram. If the food is frozen, about 80 calories is consumed in thawing it out. A coating of frost or ice may still further reduce its value. If the bird must find and dig out the food from under the snow, its troubles are greatly increased.

NORTHERN BIRDS WHICH FORMERLY WERE OFTEN SEEN IN OHIO IN WINTER

Dr. Carl Tuttle, a former member of A. O. U., has lived in Berlin Heights, Erie County, Ohio, for more than eighty years. He writes, "I distinctly remember when I was 15 years old or so of seeing every winter flocks of Snowflakes. In the last 25 years I have not seen any."

At Three Rivers, St. Joseph County, Michigan, Oscar M. Bryens kept a record of the number of birds of each species he saw in the winters, 1925–26, 1926–27, and 1945–46. He was away in the intervening winters. He saw Snow Buntings in each of the first two winters, including 97 birds, March 3, 1926, but none in the recent winter.

Elsewhere in the latitude of Toledo these birds, as well as Lapland Longspurs, Northern Shrikes, and Northern Horned Larks were formerly seen by many bird students in winter, but in a majority of recent years they have been relatively scarce. However, the largest number of Snow Buntings ever seen in one day in the Toledo area was January 31, 1943, when Mr. and Mrs. Fred Stearns saw about 5,500 at Bono.

The Common Redpoll has been rare in Ohio for more than half a century. In Dr. Wheaton's time it was a tolerably regular winter resident in northern Ohio. Lynds Jones, who came to Oberlin in 1890, says, "Previous to my residence in Ohio this species was reported as being common in the region of Oberlin nearly every winter." The numbers of Redpolls observed in the last ten years seems to have been even less than before. In the recent winter Mr. Bryens saw none in St. Joseph County, Michigan, where he saw them on 32 days in the winter of 1925–26, 78 birds March 17, 1926.

SOUTHERN BIRDS WHOSE RANGE HAS BEEN EXTENDED NORTHWARD

"In Finland the warmer climate of the past fifty years has caused the influx of birds from the south." (Margaret Nice.) In this country the northward extension of habitat has undoubtedly been favored by the milder climate, especially in the case of those birds that winter near the northern limit of their range. A factor that may have been more potent in bringing about the change is the food supply provided by man purposely or otherwise.

In western New York Cardinals are still uncommon but increasing. There has been a notable increase all the way from Pennsylvania to Illinois. Only two of the many persons consulted have reported their numbers unchanged. In the Christmas bird census at Cleveland, 103 Cardinals were counted in 1940 and farther south at Buckeye Lake, Ohio, 309 were counted in 1943. Most of the time in winter 25 or more live within 100 yards of the home of Seymour Holloway near Swan Creek, southwest of Toledo. In 1885, when I went to Grand Rapids, Michigan, to teach zoology and other subjects in the high school, the only Cardinal which the naturalists of the Kent Scientific Institute knew about had been seen not long before in the yard of Dudley Waters. At the present time hundreds of Cardinals are living in and near that city. Milton Trautman writes, "In 1925 I found Cardinals north of Grayling, Michigan, but after the 1936 winter they seemed to have been frozen back at least 100 miles to the south."

Between 1860 and 1900 most of the families in Columbus, Ohio, are said to have had a caged Cardinal. John Frey, who then made a business of trapping Cardinals, told Mr. Trautman that trappers had extirpated these birds in a 50-mile radius about Columbus and he had to go into Adams County, Ohio, and to Kentucky to trap his Cardinals. Probably something similar occurred around other cities in about that latitude. After trapping ceased, the wild birds rapidly increased.

The cutting of the forest followed by cultivation of the land made it possible for many more Cardinals to find food. Before that, buckwheat, corn, sunflower, and many kinds of weed seeds were not available in great quantities.

When a large number of people became interested in providing food for Cardinals, the birds were quick to respond and most of the other species which were attracted to feeding shelves were unable to displace them

Wild Mockingbirds were seen throughout the year in northern Ohio and even in southern Michigan for years before the beginning of the present century. They are still scarce so far north, but have become fairly numerous in recent years in the vicinity of Indianapolis and Columbus, and have extended their range northward in Pennsylvania and New England.

Dr. J. P. Kirtland, in his catalogue of the Birds of Ohio, published in the Geological Survey, in 1838, does not include any kind of Wren; there may have been none before there were buildings in Ohio. The house wren was first noticed in Dekalb County in northeastern Indiana in 1883, and until about that time there were areas in Ohio and Michigan where they were rarely, if ever, seen. Now many make their home in the woods as well as where man has provided shelter. In the Southern States the Bewick Wren and Carolina Wren have long made their homes near buildings. The northward extension of the range of the former started as early as the 1870's and the latter as early as the 1880's. Since the extremely cold periods in the winter of 1936, the Carolina Wren has been scarcer than before. They are seen occasionally as far north as Grand Rapids, Michigan. Bewick's Wren has made a steady increase at Lancaster, Ohio, in the last four years. (Charles Goslin.) It has also increased near Cleveland. (J. P. Visscher.)

In recent years the Hooded Warbler and the Prothonotary Warbler have been nesting in the North. At many places in southern Indiana the Prothonotary Warbler was first noticed in the 1880's.

The Tufted Titmouse has long been common in a considerable part of Ohio and Indiana. In recent years the number in the northern parts of Ohio and Illinois has become very great, and they have extended their range northward in Michigan and New York State. In woods near Toledo the loud call of the Titmouse is likely to be heard oftener than that of any other bird except the Blue Jay.

Wood Thrushes in the past twenty years have been more numerous than formerly in the northern part of their range.

Robins and Blue Birds are now less rare in the North in winter than they used

to be, and the former have been unusually numerous from mid-March until late in October.

Little Blue Herons are quite irregular in their visits to northern Ohio. Some have been seen in late summer in a majority of the years since 1923. In August, 1930, nearly a hundred were observed. Very few have been seen in mature plumage.

American Egrets have been seen in the North more frequently than Little Blue Herons. Since about 1925, they have been observed in Pennsylvania and northern Ohio. For some thirty years before that they were on the verge of extermination, because women paid high prices to get their ornamental plumes. Karl Bartel reports 100% increase in the Chicago area. Bernard Baker saw American Egrets near Grand Rapids, Michigan, in 1939, 1940, and 1941, and at Grand Traverse Bay in 1940. Some have been seen at Rochester, New York, since 1933. Since 1941 relatively few have been seen along streams in northern Ohio, excepting near Lake Erie. Harold Mayfield and Louis Campbell saw 80 Egrets September 3, 1944, at Reno Beach, east of Toledo, and 104 August 22, 1945, in the Erie Marsh in Michigan, north of Toledo.

Like the preceding, the Snowy Egrets were too beautiful to be allowed to live, and were sacrificed on the altar of Dame Fashion. They have long been among the rarest of Ohio birds. Although a few nested in southern Indiana half a century ago, we have no evidence that they were ever numerous north of the Ohio River. There was some increase in their numbers in the Toledo area, 1934–1939. (Louis W. Campbell.) In these years the summers were unusually hot.

"In 1879 there were but five known records of the Barn Owl in Ohio and none in Indiana." (Amos W. Butler, The Birds of Indiana, p. 800.) Early in the present century it was no longer rare in southern Ohio and there were also many living permanently in northern Ohio. For quite a number of years past Barn Owls have been among the most numerous of the larger birds of prey in this region, and perhaps the most useful, considering their numbers, of all our many useful birds. A glance at the feet of these birds will show why they are not fond of winter weather much farther north than Ohio. They remind us of the scantily-haired opossum, which had been increasing in the North for many years prior to the hard winter of 1944–45. So many perished then that several, perhaps many, years will be needed to restore their numbers. For a long time quite a number of Barn Owls have had their homes inside of large trees on one farm traversed by Swan Creek southwest of Toledo. Apparently they all survived the winter of 1944–45. Their wings enabled them to fly quickly to good places to find food and return without long exposure to the cold.

In addition to the southern birds mentioned above, all of which are attractive or easily identified, there are other species which are known or believed to have extended their range northward, for example, Bachman's Sparrow and Carolina Chickadee. A list of birds from the Southwestern and Western States which have established homes in some of the North Central States will be found under the heading, Bird Life Affected by the Activities of Man.

For many years Mourning Doves have been common over a wide area. Since early in the present century when they were considered a game bird, their numbers have steadily increased. The extension of wheat acreage in the Northwest has made them one of the most common birds there. The number now in the whole country may exceed that of any native land bird of larger size except the crow, but probably is less than the number of Passenger Pigeons in the middle of the last century. They subsist largely on weed seeds and scattered grain, doing very little harm to crops.

One reason for the increase of Mourning Doves in recent years is the fact that those which went south to spend the winter were able to return in spring, because people there were too busy with more important matters to use their

shells in shooting birds. Moreover, they have escaped the hazards that have decimated those species that habitually nest on the ground, and their nesting season covers several months, some of which are likely to be favorable for rearing their young. Combines, which are now in general use in many states, scatter a large amount of grain. This has increased the food supply for Doves.

Milder winters and more food have induced large numbers of these birds to stay farther north than formerly. Hundreds of them remain through the winter in the Toledo area. In the 1940 Christmas census 155 were enumerated there. In central Ohio the number has been larger than this at more than one place and in more than one census. In Michigan they are often seen in winter as far north as Lansing.

EFFECTS OF WET AND DRY PERIODS

In the entire record of precipitation since the Weather Bureau started in 1871 there were no other three consecutive years in which so much rain fell in northern Ohio each spring as in 1943, 1944, and 1945. At Cincinnati rain in these three springs has not been surpassed since the early 1880's. The ground was unusually wet also in the nesting season of 1942, 1940, and 1937. Ground-nesting birds must have found it difficult to rear their young in all of those years, especially where the land is so flat as it is around Bowling Green. Hungarian Partridge and Bobwhite have become rare in the Bowling Green area; the numbers of Pheasants, Meadowlarks, Bobolinks, Grasshopper Sparrows, Vesper, and Song Sparrows have been reduced. For some of them it seems probable that unfavorable nesting conditions have been the most potent factor in bringing about the change. Decrease in some of these birds may be due also to the increase of crows and of those birds of prey which feed on birds—Sharp-skinned, Coopers, and Marsh Hawks.

The dry summers that characterized most of the twelve years from 1930 to 1941 were unfavorable for many kinds of birds. July, 1936, was hot as well as dry. At that time I spent a few hours on West Sister Island in Lake Erie, where there were thousands of nests of the Black-crowned Night Herons. On the ground under the nests there were hundreds of the young birds dead or dying. These herons do not maintain a colony in one place so long as do the Great Blue Herons. For two or three decades past they have been much more numerous in northern Ohio than they were earlier in the century. The reason is probably better protection for herons in general. In a colony north of Bay City, Michigan, in 1941, Walter P. Nickell estimated there were 300 breeding pairs.

Dry summers are unfavorable for Woodcock, Snipe, Water-thrushes, and Short-billed Marsh Wrens; their numbers have been much reduced. Other birds were affected by the poor crops. In some of these summers the yield of grain, weed seeds, and berries was much less than usual.

VAGARIES OF THE WEATHER

Some meteorological phenomena not implying any change of climate occasionally cause the destruction of large numbers of birds. On dark stormy nights at time of migration many thousands have perished by flying against light houses or beacon lights. Birds whose winter range is in the Gulf and South Atlantic States have at times encountered such bad winters there that a majority perished and five or more years were needed to restore their former numbers. This is likely to occur to birds like the Phoebe, which feed on insects they catch while flying.

Thunder storms have sometimes killed many birds in summer. In one of the little parks at Sandusky, Ohio, more than a hundred English Sparrows were found dead early one morning. They had drowned in pools of water where the ground was dry the previous evening. A heavy rain after midnight had probably chilled and weakened them. Another downpour before sunrise knocked them off their perches.

At times sleet storms have proved disastrous over a wide area. Milton Trautman's observations of Carolina Wrens in the vicinity of Buckeye Lake, Ohio, illustrate this and also a great reduction in their numbers caused by severe winters. "During a sleet storm in the winter of 1917–18 a great decrease in numbers occurred and for a few years thereafter only a few pairs nested within the 40 square mile area. By late 1923 as many as 30 individuals could be recorded daily; then that winter another sleet storm greatly reduced their numbers. Other reductions in numbers occurred in 1928 and 1930. In late 1935 I recorded 40 to 50 daily; then came the severe winter of 1935–36 and after that less than 5 per day could be recorded. The numbers rose again to 25 per day in 1941. Then the two hard winters of 1943–44 and 1944–45 so reduced their numbers that in December of 1945 only one bird could be found in the area and it was at a feeding station."

EFFECT OF INTRODUCED FOREIGN BIRDS ON OUR NATIVE SPECIES

In my boyhood days in Branch County, Michigan, in the 1870's, the familiar Chipping Sparrow nested in a bush in our front yard. They were very peaceable. The aggressive English Sparrow was unknown to us. Cliff Swallows, long common in the west, became abundant in Ohio after barns were built there, affording them nesting sites under the eaves and plenty of flies for food. English Sparrows appropriated all the good nesting places they could find around the buildings. They drove these Swallows into oblivion. They made trouble too for Purple Martins and other birds, but greatly augmented the food supply of Screech Owls and Sparrow Hawks. In recent years the English Sparrows have become less numerous. In the village of Berlin Heights Dr. Tuttle estimates that less than a hundred of these unwelcome guests still remain. Their decrease may be due partly to the scarcity of horses on the roads, but probably two other factors have had more effect on their numbers. On many farms strawstacks are no longer seen, because the harvesting of small grains is done with combines and the straw, if it is not left in the field, is baled. Those straw stacks were very useful to the Sparrows, affording them protection from storms and predators, nesting sites, and considerable food. Still more important has been the competition of Starlings with Sparrows. This began before combines were in common use in Ohio and affected both country and city.

Starlings were observed in Erie and Ottawa Counties, Ohio, by Lynds Jones in 1921. They increased year after year, although the number in the state now may not be greater than it was a few years ago. Their competition with other small birds for food and nesting sites has reduced the numbers of many species, especially those that nest in holes. They are very aggressive birds and seem to delight in persecuting other kinds. One Starling, although it is armed with a sharp beak, would not make headway against a Sparrow Hawk, a Flicker, or a Red-headed Woodpecker, but by ganging up in large numbers and attacking energetically and persistently, they succeed in driving all of these birds away from the cavities in which they would like to nest. This has been an important factor in causing Red-headed Woodpeckers to become scarce where they were formerly abundant. Decrease in the number of Sparrow Hawks in some areas may be due to the same cause, although they are not always driven away by Starlings.

In many places Flickers have decreased in numbers. In some places they have held their own, or even increased. Their eviction from nesting sites by Starlings has frequently been observed, but some have eventually found cavities where they succeeded in rearing young. They are very prolific.

Downy Woodpeckers have held their own fairly well. Suet put out by their admirers has helped them. They have also benefited, and so have the farmers, from their persistence in finding European corn borers. While working in his

corn field, Seymour Holloway has noticed in one day about a dozen of these dynamic midgets diligently searching for borers in the stalks.

In Toledo there has been a notable decrease in Chickadees and Nuthatches in recent years. Their numbers have probably been reduced also in other cities where Starlings abound.

Walter P. Nickell of the Cranbrook Institute of Science near Detroit writes me, "Not one pair of Bluebirds has nested in the numerous cavities in our old apple trees back of the Museum for at least ten years, while an average of 15 or 20 nests of the Starling are found every year. Three hundred miles farther north, in Charlevois County, Starlings are much less common, and no competition between Starlings and Bluebirds for nest cavities has been observed. Cedar Waxwings are also numerous there."

The decrease in Cedar Waxwings has been observed over a wide area and has probably been caused by their inability to find enough fruit left by the Starlings.

In the last week of March, 1946, I watched outside my window a Mourning Dove as she brought sticks from the yard to build a nest in the crotch of an old silver maple. Despite annoyance from both Sparrows and Starlings she was able to complete the nest. A few days later I found, on the sidewalk beneath, two broken eggs which the Dove had laid. The large splotch and shell fragments from one of the eggs were still plain amid the droppings of Starlings a week later, but the Dove had not been seen in the tree since the eggs fell.

Ring-necked Pheasants had become well established in the Bowling Green-Toledo area by 1923, after several attempts to introduce them. The number living in Wood County in the late 1930's was estimated at 175,522. This means about a dozen birds for every family on all of the 4,816 farms in the county, as well as those living in Bowling Green and a score of smaller towns, villages, and hamlets. Most of these birds when they reach maturity weigh between two and three pounds. No one expects them to do this without consuming a large amount of food. Barnyard fowls, if not closely confined, obtain considerable food for themselves and in doing so damage various crops. Pheasants have to find nearly all of their food and the farmer cannot reasonably expect them to make a living on his land without molesting some of the crops he is attempting to grow.

Even if the Pheasants served no other good purpose, their usefulness in protecting crops from the ravages of insects and mice would offset what damage they do to sprouting grain and to unharvested grain. In dry seasons when water is hard to find they are likely to pick into many tomatoes and probably some melons, but melon growers have sometimes accused them of eating melons when they were really eating destructive insects. Crows also account for much damage which careless observers have assumed was done by Pheasants. Water in crocks in melon patches is said to lessen the damage done to the fruit by birds.

R. S. Phillips of the Findlay Bird Club counted 131 squash bugs which he found in a single Pheasant. They are known to eat also large numbers of cucumber beetles, cutworms, crickets, grasshoppers, and other destructive insects.

For a few years past the Pheasant population of Ohio has decreased to such an extent that after the shooting season of November, 1945, the number of birds in Wood County remaining alive and not crippled, was probably less than ten per cent of the average summer population during the 1930's. Naturally this is a matter of deep concern to sportsmen and to many farmers. An appraisal of the relative importance of the various factors that have brought about this decrease is difficult. I will give some of them in order of importance as I see it, but many persons who have had more experience with Pheasants will disagree with me.

1. The Shooting of Hen Pheasants Carelessly or Otherwise. Near Toledo a great many Pheasants have been killed out of season by poachers shooting from parked cars. In the excitement engendered by the great numbers of hunters

in the first few days of the open season some who are usually law-abiding have killed or crippled hen Pheasants.

In Wood County in the late 1930's it was found that about forty hen Pheasants were shot for every one hundred cocks bagged. In the past two years the percentage of Pheasants illegally killed has probably been still larger.

2. The Alfalfa Mill. These mills take care of a large amount of hay in a short time, using it before it is tall enough to afford good protection for the Pheasants. Much of the mowing is done with high-powered machinery, operating at night as well as through the day. At night many Pheasants are killed. Those nests that escape instant destruction are usually abandoned and the eggs exposed, to be consumed by Crows and four-footed prowlers.

3. The Clearing of the Banks of Ditches and Natural Streams. Formerly the saplings, bushes, brush, grass, and weeds were used by Pheasants and by many other birds for concealment and for nesting sites. They also found in them a variety of food different from the kinds found in the fields. In order to give employment to persons on relief, the work of clearing the stream banks was authorized by township trustees or county commissioners, and much of it by the C.C.C. and W.P.A. If this work is done before July 10, many nests and young birds are destroyed at the time, but whether it is done early in the summer or later, years are required to restore a favorable environment for wild life.

4. Foxes. Never before were there so many red foxes in Ohio or Michigan as in the past few years.

Tuscarawas County, 75 miles south of Cleveland, had paid bounties on 300 foxes less than two weeks after the commissioners had appropriated the money, January 1, 1946. Union County, 25 miles northwest of Columbus, paid bounties on 92 foxes, November, 1945, to January, 1946. Wyandot County, sixty miles north of Columbus, paid bounties on 43 foxes, November, 1945, to April 7, 1946. In each case the bounty was three dollars.

In the flat country south of Toledo, where nearly all of the land is cultivated, foxes have increased but are not so numerous as in rugged parts of the state.

5. Cats. In many of the Pheasant areas cats are believed to kill more of the young birds than are killed by any other predator. This is most noticeable near towns. Feral cats, which find their living entirely in the wild, are more numerous than most people realize. One farmer of my acquaintance killed fifteen feral cats in the winter, 1945–46, about half of them on his own land in Lucas County.

On the Stitt Game Preserve in Wood County, sixty of these pests were killed in one winter. Most of these feral cats were probably born in Toledo and smaller towns. Their owners, having too many, took them miles away to shift for themselves.

6. Hawks. Most kinds of hawks are not restricted to a diet of mammals, fish, or any one class of animals, but take what is easiest to get. Cooper's and Sharp-skinned Hawks are now numerous in areas where Pheasants abound. Near Lake Erie, Marsh Hawks are most numerous and probably take some young Pheasants, although as a rule birds form only a small part of their diet. Red-tailed Hawks have increased and are now so numerous in some counties that they are the worst offenders. In Wood County they are believed to kill more Pheasants than are taken altogether by other species of Hawks. In winter Rough-legged Hawks and Goshawks are uncommon or rare in Ohio, but both of these winter visitors have increased in recent years.

7. Crows. One farmer southwest of Toledo reports finding the shells of Pheasant eggs that had been eaten by Crows—enough eggs to fill a 3-gallon pail.

"During the period 1912–20 pest hunts were almost unknown in Wood County.

After that, thousands of crows were killed at their roosting places and the great rookery on the western edge of Bowling Green was broken up. Pheasants had a chance to hatch their eggs, and almost unbelievable increases were noted in the Pheasant counts."—(James Stitt.)

8. Bad Weather. In some years spring freshets have drowned out many nests of ground-nesting birds. The unusual succession of very wet springs must have frustrated the attempts of many Pheasants to rear their young, especially where the land was poorly drained. In the very dry summer months, with little dew and the vegetation withered, probably many suffered from lack of water.

The long cold winter of 1944–45, with the ground snow-covered most of the time, was hard on Pheasants. Many that would have perished were saved by man's aid. About 400 of the birds found their food in the standing corn on one farm near Monclova. A farmer near Whitehouse had an even larger number feeding during the winter in his field. Illness had kept him from harvesting the corn. He was partly reimbursed by sportsmen's clubs.

9. Other Egg Eaters. Bird eggs appeal to the appetite of a great variety of mammals, birds, and reptiles. For many species no other kind of food is more attractive. Pheasants protect their nests from small intruders, yet the number of Pheasant eggs devoured in the past twenty years in Wood County probably exceeds the number of hen eggs consumed by all the people of any one town in the county, except one or two of the largest.

One of the worst offenders is the opossum. Favored by mild weather for many years prior to the cold winter, 1944–45, these odd creatures had been increasing in Northern Ohio and Southern Michigan. In their nocturnal wanderings they find many Pheasant nests. Skunks also are notorious egg eaters; their destruction of Pheasant nests has been noticed in many places. However, their number in the Toledo area in the past few years has been less than formerly. Farmers have attributed this to the multitude of oppossums; they are believed to devour skunks in their burrows when they are hibernating. Because nearly all the opossums perished in the winter of 1944–45, the young skunks born later came through the following winter unmolested. At any rate skunks have recently been observed in unusual numbers.

Raccoons were quite numerous in 1945. Unlike opossums, they are well protected by fur coats and can hibernate for long periods of time in hollow trees, where they are safe from storms and traps. Opossums are southern animals and seem to be incapable of going long without food. Raccoons are passionately fond of eggs; they found many Pheasant nests in 1945.

Rats, the most destructive of all mammals, probably destroy many Pheasant nests. Stray dogs also are known to find and eat the eggs.

10. Owls. In the nesting season of 1945 Laurel VanCamp of Genoa, southeast of Toledo, found fifteen nests of Great Horned Owls. In many places Barred Owls are more numerous, but they probably do not kill so many Pheasants. A Snowy Owl was shot near Bowling Green, November 29, 1945, when it was carrying a Pheasant. Few, if any, are killed by Owls of other species.

11. Automobiles. These have maimed and killed numerous Pheasants and caused the death of others by aiding those unscrupulous persons who indulge in illegal shooting. "On one Sunday in 1941 I counted 70 dead Pheasants and rabbits between Findlay and Bowling Green; fully half of them were Pheasants."—(James Stitt).

PHEASANTS AND NATIVE BIRDS

Where there are not more than twenty Pheasants per square mile they may have little effect on the numbers of the other species present, but in Wood County

there have often been two or three hundred for each square mile of farm land. They have caused a large increase in the number of Hawks, Owls, and Crows, and a decrease in those species which naturally eat the same sort of food.

In Wood County in 1945 James Stitt, who for many years has spent most of his time in producing and maintaining the large Pheasant population, received the following reports of birds of prey, mostly from men in the feeding stations: Hawks shot, 671; trapped, 33; Owls shot, 19; trapped, 41. The whole number killed in 1945 within thirty miles of Bowling Green probably exceeded three thousand, including those killed by poultry raisers.

Pheasants have been seen eating the eggs of Bobwhites and Meadowlarks, although they may not search for them, nor find enough to change materially the number of successful nestings. Birds whose decrease is probably due in part to the abundance of Pheasants are Meadowlarks, Bobolinks, Grasshopper Sparrows, Vesper Sparrows, and Bobwhites. Even the Sparrow Hawks are less numerous where Pheasants are abundant, probably because their food supply is reduced both by the Pheasants and by the numerous large birds of prey that feed on the Pheasants.

For some years past the increase in the number of predators has been greater than the increase in Pheasants. "The proportion (of predation) rises and falls progressively with increase or decrease in numbers of the available food organisms." —(W. L. McAtee).

The great number of Hawks, Great Horned Owls, Crows, foxes and other predators in the past ten years may have been more effective in reducing the number of Bobwhites, Hungarian Partridges, Meadowlarks, and other species in the areas having a high concentration of Pheasants than the reduced food supply caused by their presence.

The following abridged statements show some of the conclusions of Professor Paul L. Errington of Iowa State College relative to competitive relations of Ring-necked Pheasants and Bobwhites.

"Wintering Bobwhites avoid coverts having many Pheasants, much as they do places overpopulated with their own kind.

"Even very low densities of Pheasants have their competitive significance to the Bobwhite.

"Pheasants have displayed vastly more tolerance of crowding than have the Bobwhites."

Both of these valuable birds suffer in cold winters when there is deep snow, unless they can get to ample food supplies provided by man. Of the two the Bobwhite is less hardy and succumbs more quickly to lack of food. Its chief advantage over its competitors in Ohio is that it is protected from shooting. Most of the farmers realize that it is highly beneficial to crops and does little or no harm. In large parts of the state where Pheasants have not been numerous, the Bobwhites were holding their own prior to the severe winter of 1944–45.

In Michigan also the shooting of Bobwhite is illegal, and its range has slowly extended northward as far as the Strait of Mackinac.

Crows are not foreign birds, but as trouble makers they are unsurpassed. They have not been scarce within our recollection and have shown a marked increase in Ohio in recent years, despite the fact that a great many have been shot. Their damage to crops has been very great, in many places greater than that of any other birds. They ruin tomato crops by picking into one fruit after another as soon as it turns red. They eat sprouting corn to such an extent that much replanting is necessary to get a fair crop. In some wet seasons tons of ripening corn have been ruined in a single field by crows which open the husk and eat the kernels near the top of the ear, leaving the remainder to be spoiled by beetles and fungi. They have continued to seize the eggs and young of various other birds.

The increased amount of animal protein available for them has enabled them to produce and feed more young crows. They watch ducks when they are at a distance from the farm buildings and take their eggs as soon as they are laid.

One Toledo hunter, loading his own shells, claims to have shot nearly a thousand crows in the season of 1944–45. I know a farmer who shot at least 150 in the spring of 1945. Some other farmers would have done this if they had had enough ammunition. In general the farmers are grateful to anyone who succeeds in killing crows. A few years ago, when shells were supplied to crow hunters by the state, Max Kempker of Toledo shot between six and eight thousand of these pests each year.

BIRD LIFE AFFECTED BY THE ACTIVITIES OF MAN

Decrease.—Decrease in the numbers of many kinds of birds has been caused by man. The cutting down of forests deprived numerous species of their natural habitat. Because of its great fertility, when well drained, the land in the northwest quarter of Ohio was cleared more thoroughly than other quarters of the state. It no longer has Wild Turkeys, Ruffed Grouse, Ravens, Passenger Pigeons, Carolina Paroquets, or Pileated Woodpeckers. There are still a few Red-bellied Woodpeckers. They are increasing in Eastern Ohio, Western New York, and near Chicago, probably because of better protection and milder winters.

In Wilson's time there were numerous Ravens, but no Crows, along the south shore of Lake Erie. Their extirpation in Ohio made more room for Crows, just as the later extinction of Passenger Pigeons gave more room for Mourning Doves.

In the museum at Bowling Green State University we have a well preserved Pigeon net, about fifty feet long, whose owner succeeded in catching 292 Pigeons at a single throw, thereby beating his father, whose best was an even 24 dozen, or 288 birds. This was probably about 1870.

Paroquets may never have been numerous in Ohio. In 1862 a flock of 25 or more was seen in the Capitol Square of Columbus. A specimen shot near Newark, October 9, 1884, was mounted. When I was teaching at Sandusky in the early 1890's I had a report of a Carolina Paroquet seen six miles south of that city.

Dr. William Graefe collected and had mounted many interesting specimens of birds, which are now preserved in the University Museum at Bowling Green. He told me that in 1880 he shot a Prairie Hen near Sandusky. In Ohio these birds may have lived only in those few counties which had some prairie, most of them in the northwest quarter.

Probably most of the species mentioned above would have disappeared eventually as a consequence of cutting the big timber even if they had not been hunted, but extirpation of most of them was hastened by man's desire to eat their flesh. Even the Pileated Woodpecker, or 'Logcock," was a game bird. About sixty years ago I prepared a skin of one I found at a meat market in Grand Rapids, Michigan. These large Woodpeckers have increased in recent years at some places in eastern Ohio and western Pennsylvania, due probably to better protection.

A century ago there were many Bald Eagles nesting near Lake Erie and Sandusky Bay, probably more than a hundred pairs, each using the same nest year after year, as long as it was safe. Great Horned Owls, Barred Owls, Red-tailed Hawks and Red-shouldered Hawks were also common at that time.

Great Blue Herons are still common, but probably less so than long ago. The largest heronry in Ohio contained 1,118 nests, May 2, 1935; nearly all of them were occupied. This is in Sandusky County nine miles northwest of Fremont. In the Waggoner Woods, where the heronry is now, the birds began to build nests in 1912 and 1913, because the woods three miles nearer to Lake Erie, which had previously harbored them, no longer contained enough large trees. We know that

the older site had been used continuously since about 1840. It may have been used long before that.

Close to the Michigan line, sixteen miles west and north of Toledo, is another old colony of Great Blue Herons, where Reverend Hammond counted 214 nests in 1932. Its present location, in woods of John Ford, has been used only about sixty years. This colony had previously had to change its location more than once. In 1871, year of the great Chicago fire, it was so dry in October that forest fires wrought terrible havoc to both human and avian settlements. Up to that time this heron colony had been using tall cottonwood trees in heavily timbered swamp land about four miles northwest of the Ford woods.

The number of herons in these two old colonies has depended largely on the activities of man, especially in the matter of shooting, for they were able to defend themselves from other predators and had an unfailing food supply in Lake Erie and waters connected with it. Other colonies in Ohio have declined in consequence of the destruction of forests, drainage of the land, and the long succession of dry summers, 1930–41.

Numerous other birds that lived in the forest—Tanagers, Vireos, Thrushes, Ovenbirds, Cerulean Warblers, and others are probably less numerous now.

The drainage of swamps has greatly reduced the habitable areas formerly available for Sandhill Cranes, Rails, Gallinules, Snipes, and a number of land birds which prefer to nest near water—Short-billed Marsh Wrens, Swamp Sparrows, and Yellow Warblers. The clearing away of the bushes on stream banks has decreased the favorite nesting sites of many species.

Telegraph and other wires have caused many bird fatalities, especially in the migrating seasons.

Red-headed Woodpeckers and various other birds have been hit by automobiles. Both game and song birds have been slaughtered by hunters who depended on their cars to take them to the homes of the birds.

The introduction of domestic cats, Sparrows, Starlings and Pheasants has added to the troubles of many native species.

Guns, nets, and traps have exterminated a few kinds of American birds, have reduced almost to the vanishing point several others, and materially decreased the number of many kinds.

In recent years many nests of birds that live in the open fields have been destroyed by mowing machines and by plows and other implements used in fitting the land. Introduction of the alfalfa mill accounts for the earlier mowing of meadows with resulting destruction of numerous nests.

Increase.—On the other hand, many kinds of birds have become more numerous because the activities of man have provided more food for them.

In many of the years since Bowling Green State University started, as a training school for teachers, in 1914, Golden Plover have been seen in large numbers, thousands of them in some years. On their way to their nesting grounds in Arctic America they tarry on the rich land around Bowling Green when it is being plowed for corn. Apparently some flocks remain in one neighborhood for two or three weeks. Many of the birds acquire the summer plumage while they are here. Most of them leave before May 10th. After crossing Lake Erie they probably do not make such a long stop again until they come near the Arctic Ocean. On their way back to enjoy the mild weather prevailing in the southern hemisphere during our northern winter, a few flocks are usually seen somewhere in the Toledo-Bowling Green area.

Until there were orchards, Cape May Warblers could not have found so many

insects during their fall migration. Their marked increase in recent years may be due to the fact that farmers have been too busy to spray their orchards.

We have previously mentioned southern birds which have extended their range northward both because of a milder climate and more food. The increased amount of food has helped also many other birds—Killdeer, Upland Plover, Pectoral Sandpipers, Tree Sparrows, Juncos, and other birds which had always been here for at least part of the year.

Destruction of forests, followed by cultivation of the land, made Indiana and Ohio attractive to birds which had previously lived only on the prairies or plains. A number of plants not found in forests, but common in treeless parts of the West and Southwest, migrated eastward and northeastward after the land was cleared. Some came in baled hay, or in bedding for cattle, others as impurities in seed shipped eastward for planting. Where empty cars which had carried loads of wheat were swept out, unfamiliar weeds sprang up. Many kinds were brought by the wind. Various grasses, sunflowers, and other composites, pigweeds and amaranths, and plants of the mustard and legume families which had been common in the west were brought here in one way or another and added to the food supply of native birds as well as of those whose homes had been where the plants came from.

Examples of birds formerly unknown or merely accidental east of the Illinois prairies are the Dickcissel, Lark Sparrow, Western Henslow's Sparrow, Leconte's Sparrow, Nelson's Sparrow, Western Meadowlark, and Yellow-headed Blackbird. Most of these birds are still uncommon as far east as Ohio, but the Western Henslow's Sparrow nests in considerable numbers at some places in Ohio and Pennsylvania and has increased also in New York State. Prairie Horned Larks have long been common in open places, but until the land was cleared there were none within 300 miles of Toledo. Western Meadowlarks have been observed in larger numbers, 1938–45, in Michigan, and near Indianapolis and Chicago.

Man has also augmented the food supply of birds purposely. He has left, in fence rows and hedges, weeds and shrubs whose seeds or fruit are relished by the birds. He has planted sunflowers and numerous other herbs, shrubs, vines, and trees to provide food for the birds.

Man has aided the birds in other ways. Shelters of plant growth on the borders of fields, nesting boxes, feeding shelves, drinking and bathing places have added to their safety and comfort. Putting out food for them has enabled many to survive in bad weather.

Many kinds of birds are safer when living near man. He no longer confines them to cages to hear them sing. In this country, except in lawless communities, he does not shoot song birds for food or because he has no other living creatures to shoot at.

This changed attitude toward birds has come about mainly in recent decades. Much credit for it is due the Audubon Societies and other associations for the protection of birds. Probably even more has been done by the schools, many of them aided by natural history museums. They have succeeded in getting the children interested in finding out more about the life of birds and in that way becoming more sympathetic toward them.

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LABORATORY TESTS SHOWING THE EFFECT OF DDT ON SEVERAL IMPORTANT PARASITIC INSECTS

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During the summer of 1945 the author was given the opportunity to study the effect of DDT, a new touch insecticide, on certain parasitic insects, particularly those attacking the oriental fruit moth (*Grapholitha molesta* (Busck)) and the strawberry leaf roller (*Ancylis comptana fragariae* (Walsh and Riley)). The project was a cooperative set-up between the U. S. Bureau of Entomology and Plant Quarantine and the Department of Entomology of the Ohio Agricultural Experiment Station at Wooster, Ohio. The author is indebted to N. D. Blackburn for assistance in obtaining some of the parasites and for observations made when the author was absent, to H. W. Allen of Moorestown, N. J., for shipments of living specimens of *Macrocentrus ancylivorus* Roh. and to C. F. W. Muesebeck for final determination of the species of parasitic insects tested.

The following is a brief summary of the many tests conducted in the laboratory to determine how toxic a dry deposit of DDT spray on foliage might be to parasitic adult insects that visited the treated leaves. The tests were designed to determine the strength of DDT and the exposure time required to kill, as well as the toxicity of deposits one to nine weeks old on orchard-sprayed foliage. The exploratory nature of the project gave the writer an opportunity to test various parasitic and predacious insects, however, this report is restricted to a summary of the results obtained from numerous tests with five parasitic species, namely, one braconid, *Macrocentrus ancylivorus* Roh., an important parasite of the Oriental fruit moth, reared from field-collected strawberry leaf rollers and from the potato tuber worm, (*Gnorinioschema operculella* (Bcll)), in the laboratory; two ichneumonids, *Cremastus cookii* Weed and *C. forbesi* Weed reared from field-collected strawberry leaf rollers, and two tachinids, *Nemorilla florialis* (Fall.) reared from field-collected strawberry leaf rollers and *Archytas apicifera* (Walk.) collected on sweet clover.

The DDT (2, 2-bis (p.-chlorophenyl)–1, 1, 1-trichloroethane) used was prepared by du Pont under the trade name "Deenate, 25W." This wettable powder contained 25 per cent DDT. Consequently in all the formulae employed, 4 parts were used for each single unit of DDT stated in the dosages named. Three methods of testing were employed, namely, small vials for walk-tests, large vial tests, and small wood-gauze-celluloid cage (4″ x 4″ x 6″) tests. The cage tests were most satisfactory; hence, most of the results reported are from exposures made in the cages.

Small-Vial Tests.—For testing parasites individually, especially for short exposures not exceeding 10 seconds, the small-vial walk-testing prodecure was very satisfactory. In this method a single adult was placed in a clean 15 x 80 mm. shall vial. The open end of the vial was inserted in a glass tube 15 cm. long lined in the center with 5 cm. of sprayed (dry) peach foliage. By proper orientation toward a light source (a north window) the adult was induced to walk over the sprayed foliage and into a clean 15 x 80 mm. shell vial at the opposite end. This contained a small drop of honey-agar. After the adult had entered, the vial was removed and stoppered with a moistened gauze covered cotton plug. The act of walking over the sprayed foliage required 2 to 10 seconds. When tested individually in lots of 10 replicated several times, the results with adults of *M. ancy-*

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livorus showed 60 to 90 per cent kill within 36 hours after the adults had walked over and touched a dry deposit of DDT on a peach leaf that had been sprayed with a 1-1000 water suspension of the material (i.e., 1 gram of DDT in 1000 cc. of water). In similar tests *Cremastus cookii, C. forbesi* and *Nemorilla florialis* were unaffected by the same spray, also sprays containing 1 part of DDT to 5000 and 10,000 parts water produced no kill.

Large-Vial Tests.—Numerous large-vial (1″ x 8″) tests were conducted with the various parasites. The results in most cases were very similar to the small cage tests; consequently, they will not be reviewed in this report. One or two facts, however, should be mentioned. A 10-minute exposure of *M. ancylivrous* to DDT sprayed at the rate of 1-1000 killed all the adults, while 10 minutes exposure to DDT at the rate of 1-5000 to 1-10,000 produced only 60 to 70 per cent kill. In general, the percentage killed in the large vials was not as high for a given exposure or dosage as similar tests in the cages. This may have been due to the high humidity present in the vials, especially where leaves were present for the duration of the test.

Cage Tests.—The cages used were 4″ x 4″ x 6″. The ends, top and bottom were made of wood; the back was covered with gauze, and on the front was a sliding door made of wood and celluloid. These cages resembled closely the shipping container described previously (Peterson, 1934). The principal differences were that one long side of the cage served as a bottom, the sliding door was covered with celluloid, the 2 dram homeopathic vial containing water and dental cotton was fastened in a horizontal position to the inner surface of the left end, and the piece of cardboard smeared with a honey-agar mixture was tacked to the rear inner surface of the top board. In each cage either a sprayed or an unsprayed peach twig possessing five to seven leaves and held in a 3-dram homeopathic, cotton-stoppered, water-filled vial was inserted in such a manner that some of the leaves were in contact with the gauze side of the cage which faced the outside light source. All cages were cleaned thoroughly and swabbed with 95 per cent ethyl alcohol before they were used for succeeding tests. In each cage was placed fresh water, honey-agar food, and the test peach twig, before the 10 to 25 or more adults were introduced through the cork-stoppered opening. The twig was kept in the cage for the duration of the test. In most tests more females than males were used when it was possible to determine the sexes readily. All cages were placed on the wide sill of a north window which was kept open day and hight. The temperatures within the cages agreed closely with those recorded at the Ohio Agricultural Experiment Station weather station. Usually final records were taken 36 to 48 hours after the adults were introduced. In most tests the mortality in the check cages was less than 10 per cent. If the mortality in the check cages exceeded 25 per cent, the series was considered unsatisfactory. The cages were used primarily for two types of testing, namely, (a) the determination of the dosage of DDT required to kill and (b) the effect on the toxicity of DDT-spray deposited on the foliage of peach trees which remained exposed to the weather in the orchard until used.

In the dosage tests, 10 to 25 (or more) adults, usually less than 3 days old, were used in each cage. The number employed depended upon the supply available. Two series of dosages were employed: (a) If the supply of parasites was large, dosages of DDT at the rate of 1-10,000, 1-20,000, 1-30,000, 1-40,000, 1-50,000 and 1-100,000 water suspensions were used. (b) When the parasite supply was low, dosages of 1-10,000, 1-50,000 and 1-100,000 were used. In all the tests, the peach foliage was sprayed at the specified dosages and allowed to dry thoroughly before the twigs were placed in the cages. All five species of insect parasites named previously were subjected to the dosage tests. In most cases, especially among the species of Hymenoptera, all tests were replicated several times.

Results of Dosage Tests.—In all of the experiments with all five species of parasites, a dosage of DDT at the rate of 1-10,000 killed 100 per cent, except in one replication with *C. forbesi* where 90 per cent were killed. In a number of series of tests, dosages as low as 1-50,000 killed 100 per cent, especially in tests with *M. ancylivorus* and *A. apicifera*. Also, in some of the tests with *M. ancylivorus*, 60 per cent of the adults were killed at a dosage of 1-100,000. Among the Hymenoptera, *M. ancylivorus* proved to be somewhat more susceptible to DDT than the species of *Cremastus* tested. This was most evident at dosages more dilute than 1-30,000. It was observed among the Hymenoptera that males and females were equally susceptible to DDT.

The age of the DDT deposit on foliage appeared to effect the toxicity of the material. This was indicated strongly in some of the series A dosage tests where sprayed leaves of a given test were held for 3 to 5 days and used again in the same cages with the same species of parasite. In the repeat tests with *M. ancylivorus* and *C. forbesi* the percentages of kill were lower at all dosages less than 1-20,000 than in the first tests with the same sprayed leaves. This indicates strongly that some deterioration in the toxicity of the DDT on the sprayed leaves took place during the 3 to 5 day holding period.

TABLE I

Table Showing the Effect of Age-of-Spray-Deposit on the Toxicity of DDT to *M. ancylivorus*

Dosage 1 part DDT to 1000 parts of water

Cage	Date Sprayed	Tested 7/31, 70–95° F., 50 per Cage				Tested 8/22, 61–74° F., 25 per Cage			
		Age in Days of Deposit	Inches of Rain*	No. Dead 35 Hr.	Pct. Dead	Age in Days of Deposit	Inches of Rain*	No. Dead 40 Hr.	Pct. Dead
A	Check	No DDT	3.80 (12)	10	20	No DDT	5.17 (16)	3	12
B	6/19	42	3.80 (12)	6	12	64	5.17 (16)	12	48
C	6/25	36	3.63 (11)	43	86	58	5.00 (15)	23	92
D	7/2	29	2.81 (9)	49	98	51	4.08 (12)	25	100
E	7/9	22	2.66 (7)	43	86	44	3.93 (11)	25	100
F	7/16	15	.38 (4)	50	100	43	1.65 (8)	25	100
G	7/23	8	.05 (2)	50	100	30	1.32 (6)	25	100
H	7/30					23	1.29 (5)	25	100
I	8/6					16	1.27 (4)	25	100

*The numbers in parentheses indicate the number of rains the checks and treated foliage received.

An interesting observation relating to temperature was noted in the dosage tests and also in the tests with deposits of various ages on orchard-sprayed foliage (see table). In several tests with *M. ancylivorus* and *C. forbesi*, it was observed that more rapid and more extensive kill took place when the temperatures during the cage tests averaged close to 70° F. than in similar tests where the average temperature of the cages was 80° F. and higher. Further tests are needed to substantiate these unexpected results.

Result of Age-of-Deposit-Tests.—In addition to the dosage and exposure time experiments, a series of tests with foliage sprayed at 7-day periods from June 19 to August 8 were conducted on July 2, 11, 16, 23. 30, and August 8 and 22, 1945. In these tests the adult parasites were exposed to the foliage from the orchard-sprayed trees coated once with DDT at the rate of a 1-1000 water suspension. During the season, *M. ancylivorus* was available for all the test periods;

adults of other parasites, reared from the strawberry leaf roller, were available to July 20; and *A. apicifera*, collected from sweet clover, from July 30 to August 10.

In all of the age tests where average temperature during the test period did not exceed 72° F., 100 per cent of all of the adults of all the species were killed when exposed to DDT orchard-sprayed foliage 1 to 4 weeks old. In similar tests with *M. ancylivorus*, 100 per cent kill took place with orchard-sprayed foliage 7 weeks old. If the temperature at the test period averaged 80° F. or higher, the percentage killed was reduced somewhat. Rainfall on the sprayed foliage apparently did not reduce sufficiently the toxicity of DDT to parasites to permit them to visit the treated foliage without some or complete mortality.

Individual peach trees were sprayed once with DDT at the rate of 1-1000 on the dates indicated. These trees received no further sprays or dusts during the entire season. The table shows the age of the sprayed foliage employed, the rains to which it was subjected, and the number and percentage of adults killed in two of the tests. Note that lower percentages of kill are recorded when the test was made at temperatures averaging 82° F. (July 31 test) than at temperatures averaging 68° F. (August 22 test).

SUMMARY

Tests were conducted on the effect of DDT on certain parasitic insects, particularly those attacking the oriental fruit moth (*Grapholitha molesta* Busck)) and the strawberry leaf roller (*Ancylis comptana fragariae* (Walsh & Riley)), to determine the strength of DDT and the exposure time required to kill and the toxicity of deposits 1 to 9 weeks old on orchard-sprayed foliage.

DDT was found to be exceedingly toxic to *Macrocentrus ancylivorus* Roh., *Cremastus cookii* Weed, *Cremastus forbesi* Weed, *Nemorilla floralis* (Fall.), and *Archytas apicifera* (Walk.).

In all tests except one, 1 part of DDT to 10,000 parts of water killed 100 per cent of the adults of all five species. *Macrocentrus ancylivorus* and *Archytas apicifera* showed total mortality at strengths as low as 1 part to 50,000.

DDT on peach foliage from the orchard sprayed at the rate of 1 part to 1,000 parts of water continued to be highly toxic for 4 to 7 weeks. In some tests with *Macrocentrus ancylivorus* 100 per cent kill resulted when males and females were exposed to orchard-sprayed peach foliage at least 7 weeks after a single spraying with DDT.

CONCLUSIONS

The above laboratory tests indicate that DDT may prove to be toxic to adults of many species of braconids, ichneumonids and tachinids if they touch, walk or rest on plants in the field that have been sprayed with DDT for the control of insect pests. Briefly stated, biological control of some insects may be curtailed when DDT is used extensively.

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THE LIFTING EFFECT OF QUICKSAND

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Two extremes of opinion regarding the lifting effect of quicksand may be briefly stated. One of these, in fact, the opposite of lifting effect, is exemplified by the general picture of quicksand deposits as lying in wait to entrap and engulf the unwary. This is the quicksand, not only of novels such as *Lorna Doone*, *Moonstone* and *Assignment in Brittany*, but also it is a very common belief. Certainly, each year, quicksand is the cause of loss of considerable numbers of domestic animals, of human lives and of considerable property. The other opinion was stated in 1931 in an article in *Science News Letter* (3) as follows: "You're Safe in Quicksand If

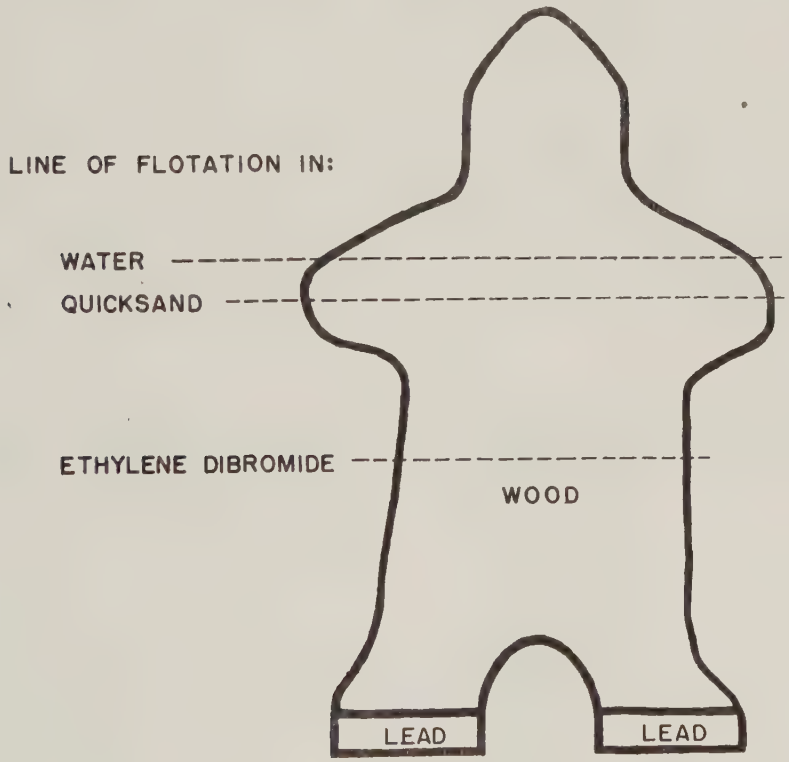

FIG. 1. Comparison of Buoyancy of Water and Ethylene Dibromide with Lifting Effect of Quicksand.

You Keep Still. . . . If you ever have the misfortune to fall into quicksand, don't get panicky and thrash around. If you keep quiet, allow yourself to go down feet first and keep your arms outstretched, you will soon find yourself resting at a depth just below your armpits. As a matter of fact, quicksand will support you twice as easily as water."

In view of the theory of what makes quicksand "quick," as proposed in 1900 by Hazen (2), later by Burt (1) and at somewhat greater length by the present writer

in 1945 (4), it was decided to test exactly the lifting power of a given quicksand. This theory, in brief, is that quicksand has its particular properties because water (a spring) is rising through it with sufficient velocity to lift the sand grains apart; thus the immersed body is going down into water, handicapped by the sand and under the lifting effect of the buoyancy of the water as well as the rising current. To study exactly this lifting effect, a model of wood (*Liriodendron*) (Fig. 1) was made, with strips of lead fastened on the feet to keep the model upright in liquids.

The levels to which it sank in water and in sand made quick by rising currents were marked on the model. (Fig. 1.) The lifting power of the particular quicksand used was then determined by use of an hydrometer to be equal to that of a liquid with a specific gravity of 1.156. This is between one-sixth and one-seventh greater than that of water. The exact level will be determined by two factors: (a) the specific gravity of the entrapped body (a man with hunting boots and a cartridge belt or a man who when swimming has difficulty floating and can easily sit down on the bottom of a swimming pool may be entirely engulfed); and (b) the velocity of the rising current. It is this second factor which leads the writer to use the term, "lifting effect," rather than buoyancy, buoyancy being only part of the "picture." The necessary velocity of the rising current will be determined by the weight of the individual grains of sand, the coarser and heavier the grain, the greater the velocity and the greater the lifting effect of the quicksand.

The lifting effect corresponding to that of a liquid with a specific gravity of 1.156 does not agree with the statement in the *Science News Letter*, ". . . quicksand will support you twice as easily as water." To check just how high a liquid with twice the buoyancy of water would lift the model, it was put in ethylene dibromide, specific gravity of 1.96. Figure 1 shows that this liquid, with a specific gravity of nearly two, lifts the model very much higher than quicksand. Thus quicksand has a lifting effect, not twice that of water, but about one and one-seventh times that of water.

REFERENCES

(1) **Burt, F. A.** 1927. Genesis of Quicksand Deposits. *Pan. Am. Geol.*, 47: 226.
(2) **Hazen, A.** 1900. Discussion of Quicksand. *Trans. Amer. Soc. Civ. Engrs.*, 43: 582.
(3) *Science News Letter.* 1941. You're Safe in Quicksand if You Keep Still. 39: 232.
(4) **Smith, Ernest Rice.** 1946. Sand. *Proc. Indiana Acad. Sci.*, 55 (In press).

CHECK LIST OF OHIO LEAFHOPPERS
(Homoptera: Cicadellidae)

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An attempt is made to list all species known to occur in Ohio. This list is based on three papers dealing especially with Ohio fauna: Osborn, Herbert, Ohio Biological Survey Bulletin 14, 1928, and Supplemental Records and Notes on Ohio Leafhoppers, *Ohio Journal of Science*, 32: 513–517, 1932; and Johnson, Dorothy M., Ohio Biological Survey Bulletin 31, 1935.

Since the publication of these papers a large number of additional species has been collected, and numerous changes, particularly in generic placement, have been made. In case the genus differs from that under which the species was listed in these papers, the old generic name follows the specific name in parentheseses and is italicized. The same treatment is used for synonymy and for varieties which have been raised to specific rank. All species which are additions are in bold face type and an asterisk is placed in front of the name. These new records may be from publications by various authors in which the species are described, or from material collected or determined more recently. The determinations have been made by D. J. Knull and all records, unless other collectors are mentioned, are from the collecting of D. J. & J. N. Knull.

A total of 615 species and 32 varieties of which 171 species and 11 varieties are new records are listed.

EURYMELINAE Kirkaldy
- **Idiocerus** Lewis
  - **alternatus** Fitch
  - ***amabilis** Ball, Ashtabula Co., June 24, 1931, E. P. Breakey; Sugar Grove, July 27, 1928, C. C. B. Mayer; Hocking Co., July 27, 1944.
  - **crataegi** V. D.
  - **duzeei** Prov.
  - **fitchi** V. D.
  - ***formosus** Ball, Hocking Co., June 19, 1938.
  - **lachrymalis** Fitch
  - **nervatus** V. D.
  - **pallidus** Fitch
  - **provancheri** V. D.
  - **scurra** (Germar)
  - **snowi** Gillette & Baker
  - ***subnitens** Sanders & DeLong, Ashtabula Co., June 24, 1931, E. P. Breakey.
  - **suturalis** Fitch
    - var. **lunaris** Ball

MACROPSINAE Evans
- **basalis** (Van Duzee)
- **bicolor** (Osborn)
- **cinerea** Breakey
- ***confusa** Breakey
- **erythrocephala** (G. & B.)
- **ferrugineoides** (V. D.)
- ***fumipennis** (G. & B.), Delaware Co., June, 1944—(*crocea* (O. & B.))
- **gleditschiae** (O. & B.)
- **insignis** (V. D.)
- **nigricans** V. D.
- **osborni** Breakey
- ***quadrimaculata** Breakey, Hocking Co., Sept. 14, 1944.
- **reversalis** (O. & B.)
- ***robusta** Breakey, Lucas Co., June 21, 1943.
- **rufocephala** Osborn
- **sordida** (V. D.)
- **suturalis** (O. & B.)
- **trimaculata** (Fitch)
- **tristis** (V. D.)
- **trivialis** (Ball)
- ***virescens** (Gmelin)
  - var. **graminea** (Fabr.)
- **viridis** (Fitch)

Oncopsis Burmeister
- **cognatus** (V. D.)
- ***fagi** (Fitch), common
- **fitchi** V. D.
- **minor** (Fitch)
- **nigrinasi** (Fitch)
- ***sobrius** (Walker)
- **variabilis** (Fitch)
- **verticis** (Say)—(*distinctus* (V. D.))

Nionia Ball
- **palmeri** (V. D.)

AGALLIINAE Kirkaldy
Agalliopsis Kirkaldy
*cervina Oman, Hocking Co., June 16, 1945.
novella (Say)—(*Agallia*)
*peneoculata Oman—(*Agallia oculata* V. D.), Little Mt., Aug. 24, 1904, J. G. Sanders, Williams Co., E. P. Breakey.
Agallia Curtis
constricta V. D.
quadripunctata (Prov.)
Aceratagallia Kirkaldy
sanguinolenta (Prov.)—(*Agallia*)

BYTHOSCOPINAE Dohrn
Stragania Stål
(**Penestragania**) Beamer & Lawson
*alabamensis (Baker), Columbus, June 29, 1942.
apicalis (O. & B.)—(*Bythoscopus*)

TETTIGONIELLIDAE Jacobi
Aulacizes
irrorata (Fabricius)
Cuerna Melichar
laterális (Fabricius)—(*Oncometopia*)
*limbata (Say)
Oncometopia Stål
undata (Fabricius)
Ciminius Metcalf & Bruner
hartii (Ball)—(*Kolla*)
Kolla Distant
bifida (Say)
geometrica (Signoret)
Helochara Fitch
communis Fitch
Graphocephala V. D.
coccinea (Forster)
versuta (Say)
Plesiommata Provancher
tripunctata (Fitch)—(*Pagaronia*)
Draeculacephala Ball
angulifera (Walker)
*antica (Walker)
*constricta Davidson & DeLong
inscripta V. D.
minor (Walker)
mollipes (Say)
prasina (Walker)—(*noveboracensis*) (Fitch))
Neokolla Melichar
gothica (Signoret)—(*Cicadella*)

EVACANTHINAE Baker
Evacanthus LaPeletier & Serville
acuminatus (Fabricius)

GYPONINAE Stål
Penthimia Germar
americana Fitch
Gypona Germar
melonata Spångberg
Gyponana Ball
*acia DeLong, Columbus, June 20, 1945; Delaware Co., July 16; Hocking Co., July 26, 1945.
*amara DeLong
*arcta DeLong, on hemlock, Fairfield Co., July 10, 1945; Hocking Co., July 2, 1945.
*brevihama DeLong
*cacumina DeLong
*conferta DeLong
*contractura DeLong
*expanda DeLong
*extenda DeLong
*flavilineata (Fitch)
*gladia DeLong, Hocking Co., June 10, July 2, 1945.
*lamina DeLong
*mali DeLong
*morosita DeLong
octolineata (Say)—(*Gypona*)
*var. serpenta DeLong, Fairfield Co., June 10, 1945.
*ortha DeLong, common
*palma DeLong
*panda DeLong
*pingua DeLong
*protenta DeLong
*salsa DeLong
*scrupulosa (Spångberg)
*serrata DeLong
striata (Burm.)
*tenella (Spångberg)
*trigona DeLong, Hocking Co., August 29. 1943.
*tubera DeLong
*turbina DeLong
unicolor (Stål)—(*Gypona*)
*vasta DeLong
Rugosana DeLong
*querci DeLong—(*Gypona rugosa* Spångberg)
Ponana Ball
*aenea DeLong
limbatipennis (Spångberg)—(*scarlatina* var.)
limonea Ball & Reeves (*scarlatina* var.)
pectoralis (Spångberg)—(*scarlatina* var.)
puncticollis (Spångberg)
*quadralaba DeLong
*rubida DeLong
scarlatina (Fitch)—(*rodora* Ball)

LEDRINAE (Stål)
Xerophloea Germar
majesta Lawson
major Baker
viridis (Fabricius)

DORYDIINAE V. D.
Parabolocratus Fieber
flavidus Signoret
major Osborn
*rotundus DeLong
viridis (Uhler)
APHRODINAE Kirk.
Aphrodes Curtis
albifrons (Linn.)—(*Acucephalus*)
bicinctus (Schrank)—(*Acucephalus nervosus* (Schrank))
flavostrigatus (Donovan)—(*Acucephalus flavostriatus*)
Xestocephalus V. D.
brunneus V. D.
coronatus O. & B.
nigrifrons Osborn
piceus Osborn

*provancheri Knull
pulicarius V. D.
*similis Peters, Columbus, August, 1944; Delaware Co., August 9 and 24, 1944.
superbus (Prov.)
tessellatus Van Duzee

ATHYSANINAE Van Duzee
Sanctanus Ball
sanctus (Say)—(*Scaphoideus*)
Scaphoideus Uhler
*auctus DeLong & Mohr, Put-in-Bay, July 5, 1935, J. N. Knull.
*baculus DeLong & Mohr, Columbus, July 14 and 22, 1934, Whittington, (A. C. Miller Collection).
*bifurcatus DeLong & Mohr, Hocking Co., July 26, August 16, 1945; Fairfield Co., July 26, 1945.
carinatus Osborn
*chelus DeLong and Beery, Fairfield Co., July 26; Hocking Co., July 2.
cinerosus Osborn
*cylindratus DeLong & Beery, Hocking Co., June 20 and July 26, 1945.
*densus DeLong & Beery, Little Mt., August 21, 1904 (Osborn collection), paratype.
*dilatus DeLong & Mohr, Delaware Co., August 2, 1945.
*frisoni DeLong & Mohr, Fairfield Co., June 16, 1945.
immistus (Say)
incisus Osborn, common
flexus DeLong & Mohr, new synonymy
*littoralis Ball, Columbus, July 27, 1944.
luteolus V. D.
major Osborn
melanotus Osborn
minor Osborn
*nigrellus DeLong & Mohr, Morrow Co., August 20, 1938, E. S. Thomas; Delaware Co., August 22, 1945; Medina Co., August 28, 1945.
nigricans Osborn
obtusus Osborn, Delaware Co., July 2 and 4, 1944; Hocking Co., July 10, 1945.
ochraceous Osborn
opalinus Osborn
productus Osborn
*pullus DeLong & Mohr, Hocking Co., July 10, 1945; Pickaway Co., June 22, 1945.
*scelestus DeLong & Mohr, Hocking Co., August 1, 1944; Franklin Co., July 14, 1942.
*tergatus DeLong, Morrow Co., August 20, 1938, E. S. Thomas; Champaign Co., July 29, 1934, F. Whitington (A. C. Miller Collection); Delaware Co., Aug., Sept., 1944–45; Fairfield Co., July 26, 1945.
*transeus DeLong & Beery, Hocking Co., July 2.
*veterator DeLong & Beery, Fairfield Co., August 15, 1945.
Lonenus DeLong
intricatus (Uhler)—(*Scaphoideus*)
Osbornellus Ball
*alatus Beamer, Hocking and Fairfield Counties.
auronitens (Prov.)—(*Scaphoideus*)
*clarus Beamer, Monroe Co., July 6, 1943.
consors (Uhler)—(*Scaphoideus*)
*corniger Beamer, Columbus, July 27, 1944; Delaware Co., August 24, 1944.
jucundus (Uhler)—(*Scaphoideus*)
*limosus DeLong, Hocking Co., August 1, 1944; September 3, 1943.
*radix DeLong & Mohr, Columbus, July 28, 1928, C. C. B. Mayer.
*rotundus Beamer
scalaris (V. D.)—(*Scaphoideus*)
unicolor Osborn—(*Scaphoideus*)
Prescottia Ball
lobata (V. D.)—(*Scaphoideus*)
Platymetopius Burmeister
vitellina (Fitch)—(*Platymetopius*)
Japanus Ball
hyalinus (Osborn)—(*Platymetopius*)
Scaphytopius (*Cloanthanus*) Ball
acutus (Say)—(*Platymetopius*)
*angustatus (Osborn), Hocking Co., October 17, 1944, det. Hepner.
*argutus (DeLong), Ashtabula Co., June 24, 1931, C. C. B. Mayer, det. Hepner.
*bicolor (DeLong), Hocking Co., September 16, 1943; Fairfield Co., June 16, 1945.
cinereus (O. & B.)—(*Platymetopius*)
cuprescens (Osborn)—(*Platymetopius*)
frontalis (V. D.)—(*Platymetopius*)
fulvus (Osborn)—(*Platymetopius*)
*hastus DeLong, Hocking Co., June, July, August, October; Scioto Co., June 10, 17.
*latus (Baker)
magdalensis (Prov.)—(*Platymetopius*)
*nigrifrons (DeLong), Delaware Co., June July; Hocking Co., July, September.
*obscurus (Osborn)—(*Platymetopius*)
*scriptus (Ball), Delaware Co., June, July, August, September; Cedar Swamp, September 5, 1941; Champaign Co., July 29, 1934, F. Whittington (A. C. Miller Collection).
*triangularis DeLong, Delaware Co., June, July, September; Hocking Co., June, September 14, 1944; Scioto Co., June 10, 17.
Acurhinus Osborn
pyrops (Crumb)
Flexamia DeLong
abbreviata (O. & B.)—(*Deltocephalus*)
areolata (DeLong)—(*Deltocephalus*)
*atlantica (DeLong)
imputans (O. & B.)—(*Deltocephalus*)
inflata (O. & B.)—(*Deltocephalus*)
picta (Osborn)—(*Deltocephalus*)
reflexa (O. & B.)—(*Deltocephalus*)
sandersi (Osborn)—(*Deltocephalus*)
*stylata (Ball)
Latalus DeLong & Sleesman
configuratus (Uhler)—(*Deltocephalus*)
sayi (Fitch)—(*Deltocephalus*)
Palus DeLong & Sleesman
delector (S. & D.)—(*Deltocephalus*)
Polyamia DeLong
apicata (Osborn)—(*Deltocephalus*)
compacta (O. & B.)—(*Deltocephalus*)

inimica (Say)—(*Deltocephalus*)
interrupta (DeLong)—(*Deltocephalus*)
obtecta (O. & B.)—(*Deltocephalus*)
weedi (V. D.)—(*Deltocephalus*)
Laevicephalus DeLong
*__acus__ (S. & DeL.), Scioto Co., June 10, 17, 1944; Hocking Co., September 16, 1943.
debilis (Uhler)—(*Deltocephalus*)
melsheimerii (Fitch)—(*Deltocephalus*)
minimus (O. & B.)—(*Deltocephalus*)
*__parvulus__ (Gill.), Scioto Co., June 1, 1945.
*__spicatus__ (DeLong), Scioto Co., June 10, 17, 1944; Hocking Co., June 3, 1943.
striatus (L.)—(*Deltocephalus*)
sylvestris (O. & B.)—(*Deltocephalus*)
*__uhleri__ Oman
unicoloratus (O. & B.)—(*Deltocephalus*)
Amplicephalus DeLong
osborni (Van Duzee)—(*Deltocephalus*)
simplarius (O. & B.)—(*Deltocephalus simplex* V. D.)
Deltocephalus Burmeister
balli V. D.
caperatus Ball
flavicostus (Stål)
*__pulicarius__ (Fallén)
Unerus DeLong
*__colonus__ (Uhler), Hocking Co., September 9, 1939.
Lonatura O. & B.
catalina O. & B.
Amblysellus Sleesman
curtisii (Fitch)—(*Euscelis*)
Amphipyga Osborn
balli Osborn
Driotura Osborn & Ball
gammaroides (V. D.)
*var. **flava** O. & B., Cantwell Cliffs, August 11, 1934, Whittington (A. C. Miller Collection).
*var. **fulva** O. & B., Hocking Co., August 5, 1945, Whittington (A. C. Miller Collection).
Doratura Sahlberg
*__stylata__ (Bohemann), Oak Openings, Lucas Co., July 20, 1943.
Exitianus Ball
obscurinervis (Stål)—(*Euscelis*)
Limotettix Sahlberg
parallelus (V. D.)—(*Euscelis*)
striolus (Fallén)—(*Euscelis*)
Euscelis Brullé
extrusus (V. D.)
sahlbergi (Reuter)—(*deceptus* S. & DeLong)
Ophiola Edwards
anthracina (V. D.)—(*Euscelis*)
cornicula (Marsh)—(*Euscelis plutonius* Uhler)
cuneata (S. & DeL.)—(*Euscelis*)
*__osborni__ Ball, Scioto Co., June 17, 1944.
striatula (Fallén)—(*Euscelis*)
uhleri (Ball)—(*Euscelis*)
Stirellus O. & B.
bicolor V. D.
*__convexus__ Thomas
*__obtutus__ V. D., Adams Co., October 12, J. S. Caldwell.
Aligia Ball
*__modesta__ (O. & B.), Delaware Co., August 2, 9, 1945; Fairfield Co., July 10, 1945.
Mesamia Ball
nigridorsum Ball
*__straminea__ (Osborn)
Bandara Ball
aurata (Ball)—(*Eutettix*)
*__curvata__ Knull
*__inflata__ Knull
johnsoni (V. D.)—(*Eutettix*)
*__parallela__ Knull
Opsius Fieber
stactogalus Fieber—(*Eutettix*), common on larch.
Eutettix Van Duzee
*__brunneus__ Osborn, Delaware, Hocking, Fairfield, Licking and Medina Cos., *Carpinus*.
luridus (V. D.)
marmoratus V. D.
querci G. & B.
southwicki V. D.
subaenus (V. D.)
Norvellina Ball
chenopodii (Osborn)—(*Eutettix*)
helenae Ball
*__pulchella__ (Baker), Athens, June 25, 1932, W. C. Stehr.
seminuda (Say)—(*Eutettix*)
Menosoma Ball
cincta (O. & B.)—(*Eutettix*)
Orientus DeLong
*__ishidae__ (Mats.), Bexley, Columbus
Iowanus Ball
*__borrori__ (DeLong)
majestus (O. & B.)—(*Phlepsius*)
Texananus Ball
decorus (O. & B.)—(*Phlepsius*)
rufusculus (O. & L.)—(*Phlepsius*)
spatulatus (V. D.)—(*Phlepsius*)
Paraphlepsius Baker
apertus (Van Duzee)—(*Phlepsius*)
brunneus (DeLong)—(*Phlepsius*)
cinereus (V. D.)—(*Phlepsius*)
collitus (Ball)—(*Phlepsius*)
*__eberneolus__ (O. & L.)—(*Phlepsius*)
fulvidorsum (Fitch)—(*Phlepsius*)
fuscipennis (V. D.)—(*Phlepsius*)
var. **turpiculus** (Ball)—(*Phlepsius turpiculus*)
incisus (V. D.)—(*Phlepsius*)
irroratus (Say)—(*Phlepsius*)
maculosus (Osborn)—(*Phlepsius*)
punctiscriptus (V. D.)—(*Phlepsius*)
pusillus (Baker)—(*Phlepsius*)
ramosus Baker
*__slossonae__ (Ball)—(*Phlepsius*)
solidaginis (Walker)—*Phlepsius nebulosus* V. D.)
strobi (Fitch)—(*Phlepsius uhleri* V. D.)
tenessus (DeLong)—(*Phlepsius*)
tigrinus (Ball)—(*Phlepsius*)
truncatus (V. D.)—(*Phlepsius*)
tullahomi (DeLong)—(*Phlepsius*)
Fieberiella Signoret
*__florii__ (Stål), Columbus, July, 1944, at light.

Acinopterus V. D.
acuminatus V. D.
Idiodonus Ball
kennicotti (Uhler)—(*Thamnotettix*)
Colladonus Ball
clitellarius (Say)—(*Thamnotettix*)
*var. **marcidus** Ball
Colladonus Ball
collaris (Ball)—(*Thamnotettix*)
furculatus (Osborn)—(*Thamnotettix*)
Doleranus Ball
longulus (O. & B.)—(*Thamnotettix*)
vividus (Crumb.)—*Chlorotettix*)
Atanus Oman
*__perspicillatus__ (O. & B.), Athens, September 2, 1933, W. C. Stehr; Columbus, July, August, 1944, at light.
Thamnotettix Zetterstedt
simplex H. S.—(*Chlamydatus* (Prov.))
Cicadula Zetterstedt
melanogaster (Prov.)—(*Thamnotettix*)
cyperacea (Osborn)—(*Thamnotettix*)
Elymana DeLong
inornata (V. D.)—(*Thamnotettix*)
Graminella DeLong
fitchi (V. D.)—(*Thamnotettix*)
nigrifrons (Forbes)—(*Thamnotettix*)
pallidula (Osborn)—(*Thamnotettix*)
Chlorotettix V. D.
*__attenuatus__ Brown
balli Osborn
galbanatus V. D.
*__iridescens__ DeLong
lusorius (O. & B.)
spatulatus Osborn & Ball
tergatus (Fitch)
*__tunicatus__ Ball, Hocking Co., June 26, 1944, September 14, 1944.
unicolor (Fitch)
*__vacunus__ (Crumb), Hocking Co., September 16, 1943.
viridius Van Duzee
Davisonia Dorst
*__delongi__ Dorst
*__major__ Dorst
punctifrons (Fallén)—(*Cicadula*)
var. **repleta** (Fieber)—(*Cicadula*)
Macrosteles Fieber
divisa (Uhler)—*Cicadula sexnotata* (Fallén)
lepida (V. D.)—(*Cicadula*)
potoria (Ball)—(*Cicadula*)
*__scripta__ (DeLong)
slossonae (V. D.)—(*Cicadula*)
variata (Fallén)—(*Cicadula*)

JASSINAE Amyot & Serville
Jassus Fabricius
borealis Spångberg
melanotus Spångberg
olitorius Say
Neocoelidia G. & B.
tumidifrons G. & B.
Paracoelidia Baker
tuberculata Baker, Hocking Co., October 5, 1935, J. S. Caldwell.

BALCLUTHINAE Baker
Balclutha Kirkaldy
abdominalis (V. D.)—(*Eugnathodus*)
impicta (V. D.)
*var. **osborni** V. D.
*var. **maculata** Davidson & DeLong
punctata (Thunberg)
Nesosteles Kirkaldy
*__neglecta__ (DeLong & Davidson)

CICADELLINAE
Alebra Fieber
albostriella (Fallén)
var. **pallidula** (Walsh)
var. **agresta** McAtee
var. **fulveola** (H.-S.)
*var. **rubrafrons** DeLong, Columbus, July, 1945; Delaware Co., July 8, 1945.
*__bicincta__ DeLong, Delaware Co., August 9, 1945.
fumida Gillette
Dikraneura Hardy
abnormis (Walsh)
angustata Ball & DeLong
cruentata Gillette
var. **kansiensis** Lawson
maculata Gillette
mali (Prov.)
*__mera__ McAtee, common on oak in southern and central Ohio.
urbana Ball & DeLong—(*abnormis* var. *urbana*)
Alconeura Ball & DeLong
*__macra__ Griffith, Hocking Co., April 30
Forcipata DeLong & Caldwell
*__loca__ DeLong & Caldwell—(*Dikraneura fieberi* (Löw)
*__ohioensis__ DeLong & Caldwell
Empoasca Walsh
Subgenus **Kybos** Fieber
albolinea Gillette
atrolobes Gillette
aureoviridis (Uhler)
maligna Walsh—(also as *denticula* Gillette)
obtusa Walsh
osborni Hartzell
patula DeLong
pergandei Gillette
smaragdula (Fallén)
trifasciata Gillette
unica Provancher
Subgenus **Hebata** DeLong
alboneura Gillette
Subgenus **Empoasca** Walsh
bicorna DeLong & Caldwell
bifurcata DeLong
birdiae Goding—(*infusca* DeLong)
coccinea Fitch
convergens DeLong & Davidson
*__curvatura__ Davidson & DeLong
*__davidsoni__ DeLong—(*mucronata* Davidson & DeLong)
distracta DeLong & Caldwell
ditata DeLong and Caldwell
erigeron DeLong
fabae (Harris)—(also as *flavescens* (Fab.))
hama DeLong & Caldwell
junipera DeLong
lata DeLong & Caldwell
pallida Gillette—(*constricta* DeLong & Davidson)

*perlonga Davidson & DeLong
pyramidata DeLong & Caldwell
radiata Gillette
recta DeLong & Caldwell
recurvata DeLong
spira DeLong & Caldwell
torqua DeLong & Davidson
venusta DeLong & Davidson
vergena DeLong & Caldwell
Cicadella Dumeril
clavalis (McAtee)—(*Eupteryx*)
flavoscuta (Gillette)—(*Eupteryx*)
*melissae (Curtis), Put-in-Bay, September 18, 1945, on mint, Mary Auten Trautman, D. J. & J. N. Knull—(*Epteryx*)
nigra (Osborn)—(*Eupteryx*)
Typhlocyba Germar
Ulmi Group
*foliosa Knull
*piscator McAtee, Hocking Co., May 25, 1938; Delaware Co., September 9 and 10, 1943; Ashland Co., Mary Auten; Scioto Co., June 9, 1943, June 10, 1944.
*sciotoensis Knull
*ulmi Linn., Columbus, at light, summer of 1943. Knulls' residence, one female specimen.
unca McAtee
Rosae Group
*athene McAtee, Columbus, August, 1944.
aureotecta S. & DeL.
cymba McAtee
duplicata McAtee
froggatti Baker—(*xanthippe* McA.)
gillettei V. D.
var. apicata McAtee
var. casta McAtee
var. fitchi McAtee
var. russeola McAtee
*var. saffrana McAtee, Delaware Co., May 21, July 2; Fairfield Co., June 16, 1945.
var. sellata McAtee
var. sincera McAtee
var. venusta McAtee
var. vestita McAtee
*var. volans McAtee, Delaware Co., June 20, 1943.
*hockingensis Knull
*lancifer McAtee, Ashland Co., June 26, 1935, Mary Auten; Shawnee Forest, June 9, 1943; Columbus, A.I.U. Tower, June 21, Vergil Argo.
*melite McAtee
modesta Gibson
phryne McAtee
pomaria McAtee
*putmani Knull
rosae (L.)
rubriocellata (Malloch)
*shawneeana Knull
tunicarubra Gillette
Danae Group
antigone McAtee
appendiculata Malloch
berenice McAtee
*eurydice McAtee, Clifton, June 14, 1938; Franklin Co., July 14, 1942; Monroe Co., July 6, 1943; Hocking Co., July 12, 1943.
*hinei Knull
nicarete McAtee, common on oak
Hymetta McAtee
anthisma McAtee
balteata Fairbairn
var. mediana Fairbairn
distincta Fairbairn
trifasciata (Say)
Erythroneura Fitch
Vulnerata Group
atrata Johnson
*fulmina McA., Scioto Co., June 17, 1944
nigerrima McAtee
var. decora McAtee
nigra (Gillette)
pulchella Rob.
vulnerata Fitch
Obliqua Group
abolla McAtee
aenea Beamer
*alata Knull
albescens Beamer
alternata Johnson
*amabilis McAtee, Fairfield Co., June 16, 1945.
autenae Johnson
bicornis Beamer
bitincta McAtee
brundusa Robinson
*caerula Beamer
caldwelli Johnson
*cauta Beamer
celebrata Johnson
clavata DeLong
*coarctata Beamer
complicata Johnson
cornipes Beamer
*cotidiana Beamer
crataegi Johnson
crevecoeuri (Gillette)
cruciformis Beamer
diffisa Beamer
*divisa McAtee
dowelli Beamer
electa McAtee
eluta McAtee
fragilis Johnson
fulvocephala Robinson
fumida (Gillette)
funesta Robinson
gleditsia Beamer
hamata Beamer
harpax Beamer
*iconica McAtee
*idonea Beamer
inconspicua Johnson
*infinita Beamer
intricata Johnson
kanza Robinson
latapex Beamer
lawsoniana Baker
magnacalx Beamer
minima Johnson
minuta Johnson
modica Beamer
noeva (Gillette)
nondescripta Johnson
obliqua (Say)
penelutea Beamer

*perita Beamer
plena Beamer
*praecisa Knull
repleta Johnson
rubens Beamer
rubrataeniensis Beamer
rubroscuta (Gillette)
rubrotincta Johnson
rufostigmosa Beamer
var. subnila Beamer
*sagittata Beamer
sincera Johnson
sinua Johnson
spatulata Beamer
*spearca Auten & Johnson, Hocking Co., April 17, 1938, October 17, 1941; Shawnee Forest, June 9, 1943.
stolata McAtee
stylata Johnson
*tenebrosa Knull
tenuispica Beamer
*torva Beamer
tridens Beamer
unicuspidis Beamer
volucris Beamer

Maculata Group
abjecta Beamer
accola McAtee
aculeata Beamer
adunca Beamer
aesculi Beamer
affinis Fitch
arta Beamer
certa Beamer
basilaris (Say)
bella McAtee
*bifida Beamer, Ashland Co., June 16, Mary Auten.
bigemina McAtee
bispinosa Beamer
calamitosa Beamer
campora Robinson
carmini Beamer
certa Robinson
*clara Beamer, Coal Grove, April 24, 1934, J. S. Caldwell; Lawrence Co., April 29, J. S. Caldwell.
clavipes Beamer
*concisa Beamer, Hocking Co., July 14, 1934, Mary Auten; Cedar Swamp, September 5, 1941.
confirmata Beamer
*consueta Beamer, Hocking Co., May 13, 1934, D. M. Johnson; July 14, 1934, Mary Auten.
contracta Beamer
*corylorubra Knull
crinita Beamer
curta Beamer
*curvata Beamer, Hocking Co., June 1, 1938.
dira Beamer
dumosa Beamer
*era McAtee, Pickaway Co., February 20, J. S. Caldwell.
*firma Beamer, Pickaway Co., February 20, J. S. Caldwell.
*forfex Beamer, Pickaway Co., March 31, 1934; February 20, and Jackson Co., April 1, J. S. Caldwell.
gemina McAtee
hartii (Gillette)
hymac Robinson
illinoiensis (Gillette)
var. spectra McAtee
*impar Beamer, Port Clinton, May 4, 1934; Pickaway Co., February 20, J. S. Caldwell.
*incondita Beamer, Hocking Co., April 15, 1934, J. S. C.; May 27, 1934, D. M. Johnson; Pickaway Co., March 31, 1934, February 20, J. S. Caldwell; Hocking Co., May 5.
*inepta Beamer, Hocking Co., March 27, 1938, Mary Auten.
*ingrata Beamer, Chesapeake, April 29, 1934, J. S. Caldwell; Pickaway Co., February 20, J. S. Caldwell.
kansana Baker
knighti Beamer
lawsoni Robinson
*lenta Beamer, Hocking Co., May 5, April 1, 1938, and June 28.
lunata McAtee
maculata (Gillette)
manus Beamer
marra Beamer
minor Beamer
mira Beamer
mirifica Beamer
morgani (DeLong)
*nigriventer Beamer, Hocking Co., May 8, 1937; Jackson Co., April 1, J. S. Caldwell.
noncuspidis Beamer
osborni (DeLong)
*pallida Knull & Auten, Hocking Co., March 27, 1938, Mary Auten.
parallela McAtee
*parva Beamer, Jackson Co., April 1, 1934, J. S. Caldwell.
*parvipes Beamer, Pickaway Co., February 20, J. S. Caldwell.
penesica Beamer
propria Beamer
pyra McAtee
*restricta Beamer, Pickaway Co., March 31, 1934, J. S. Caldwell; Hocking Co., May 5, June 28.
retusa Beamer
rotunda Beamer
*rubranotata Beamer, Coal Grove, April 24, 1934, J. S. Caldwell.
rubraza Robinson
sancta Beamer
separata Beamer
*spinifera Beamer, Hocking Co., May 5, June 1, 1938.
tantilla Beamer
torella Robinson
triangulata Beamer
trivittata Robinson
turgida Beamer
*uncinata Beamer, Hocking Co., June 28.
unica Beamer
usitata Beamer

Tecta Group
ligata McAtee
rosa Robinson

tecta McAtee
Comes Group
aclys McAtee
acuticephala Robinson
amanda McAtee
***aza** Robinson, Cedar Swamp, April 24, 1934, J. S. Caldwell; Delaware Co., August 20, 1943; Hancock Co., August 7, 1939, Mary Auten.
beameri Robinson
***bidens** McAtee, Clifton, June 14, 1938; Hocking Co., June 5 and 19, 1938; Scioto Co., June 10, 1944.
bistrata McAtee
var. **stricta** McAtee—(*vitis* var.)
calycula McAtee—(*tricincta* var.)
cancellata McAtee
comes (Say)
compta McAtee
var. **rufomaculata** McAtee
corni Robinson
cymbium McAtee—(*tricincta* var.)
delicata McAtee—(*lacta* Rob.)
var. **accepta** McAtee—(*scripta* McA.)
diva McAtee—(*tricincta* var.)
elegans McAtee
***festiva** Beamer, Knox Co., September 17, Mary Auten; Richland Co., October 6, Mary Auten; Scioto Co., June 17, 1944.
***fraxa** Robinson, Coal Grove, April 29, 1934, J. S. Caldwell; Scioto Co., June 17, 1944.
infuscata (Gillette)
integra McAtee—(*tricincta* var.)
kanwakae Robinson
***kennedyi** Knull
noncincta Johnson—(*calycula* var.)
nudata McAtee—(*attenuata* Johnson)
omaska Robinson
ontari Robinson
palimpsesta McAtee
pontifex McAtee—(*breakeyi* Johnson)
***prima** Beamer, Hocking Co., August 16, 1945.
prosata Johnson—(*infuscata* var.)
reflecta McA.—(*portea* Rob.)
rubra (Gillette)
rubrella McAtee
tricincta Fitch
vaga Johnson
***vagabunda** Knull
vitifex Fitch
vitis (Harris)
var. **corona** McAtee
ziczac Walsh
var. **walshi** Beamer, Ashland Co., May 8, Mary Auten.

NOTES ON NYMPHS OF THE DRAGONFLY GENUS HELOCORDULIA NEEDHAM

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The genus *Helocordulia* was described by Needham (1901, page 495) to include the species *uhleri* (Selys), recorded from Ontario, Maine, Pennsylvania, and New Jersey, and *selysii* (Hagen) from Georgia and North Carolina. *Helocordulia*, on the basis of adult structure, belongs to Williamson's (1908) Group 1 of the *Cordulinae*. Walker (1925, pages 17–18) subdivides Williamson's main group, affiliating *Helocordulia* with *Tetragoneuria* and *Epicordulia* in Subgroup A, with *Somatochlora*, *Dorocordulia*, and *Cordulia* comprising Subgroup B. There are no several characters that will separate all of the nymphs of the *Cordulinea* from those of the *Libellulinae*, so the genera of the family *Libellulidae* are keyed out together. Within the *Cordulinae*, however, the nymphs may be grouped (as genera) in the following manner:

GROUP 1. (*Helocordulia*, *Tetragoneuria*, *Epicordulia*)—Lateral spines of segment 9 reaching to tip of superior anal appendage or beyond; lateral spines of segment 8 not set at an angle to long axis of abdomen; dorsal hooks well developed, hooked and with a sharp apex; clefts of crenulations on distal margin of lateral lobe shallow or medium in depth, the lobes or teeth about as broad as long, always as broad or broader than depth of adjoining cleft.

GROUP 2. (*Neurocordulia*, *Platycordulia*)—Lateral spines of segment 9 as in Group 1; lateral spines of segment 8 set at an angle to long axis of the abdomen (not so obvious in *N. yamaskanensis* as in *N. obsolata*); dorsal hooks, especially on segments 6 to 9, knob-like with blunt rounded apex; clefts of crenulations on distal margin very deep, the lobes or teeth elongate, dorsal ones twice or more as long as broad.

GROUP 3. (*Somatochlora*, *Dorocordulia*, *Cordulia*)—Lateral spines of segment 9 reaching to or proximal of middle of superior anal appendage (in majority of species hardly reaching to base of appendage); dorsal hooks (with exception of a few species of *Somatochlora*) low rudimentary or altogether absent.

Genus **Helocordulia** Needham

The nymphs of this genus may be separated from all other members of the family *Libellulidae* by the following characters: Clefts of crenulations on distal margin of lateral lobe shallow, one-half or less as deep as lobes or teeth are broad; lobes or teeth about as long as broad, or less.

Large, cultiform dorsal hooks on abdominal segments 7 to 9; a small hook or indistinct mid-dorsal prominence on segment 6; hooks or any indications completely absent from abdominal segments 1 to 5. Lateral spines on segments 8 and 9, those of segment 8 parallel, not at an angle, to long axis of abdomen; those of segment 9 reaching to or slightly beyond tips of superior anal appendage. Superior and lateral anal appendages subequal in length; anal appendages short and stubby, considerably shorter than mid-dorsal length of segments 8 and 9. Distal half of dorsal surface of mentum with no setae (as is characteristic of *Epicordulia*).

KEY TO SPECIES OF HELICORDULIA NYMPHS

Dorsal hook on abdominal segment 6 small, but definitely a spine-like structure with an acute apex (as seen from lateral view); lateral spines of segment 8 subequal to or slightly shorter than those of segment 9 ..... **Uhleri**

Mid-dorsum of segment 6 with a thickened area, a mere suggestion of a tubercle, not spine-like and sharp pointed; lateral spines of segment 8 about one-half those of segment 9, **Selysii**

Helocordulia uhleri (Selys)

In 1939 the writer recorded *Helocordulia selysii* from Louisiana, based on two male nymphs collected in Bayou Lacombe at the State Fish Hatchery near Mandeville, La., January 9, 1938, and a female nymph from the Tickfaw River at Greensburg, La., January 22, 1938. Although these specimens did not agree in all respects with the description and figures by Kennedy (1924), they were labeled *selysii* because: 1) from known collections *selysii* is a southern and *uhleri* a northern species; 2) the presence of 7 lateral setae stated by Needham (1929) as a distinguishing character (*uhleri* having 6); and 3) the indefinite description of the dorsal hook of segment 6. At a later date, we secured a female nymph from Halls Mill Creek, Mobile County, Alabama, February 12, 1938, and a female nymph from Robinson Creek, Hardin County, Tennessee, June 2, 1945. A study of these specimens and a review of the literature showed that the Alabama and Tennessee specimens as well as those from Louisiana belonged to *uhleri*. This correction should be made to the paper by Wright (1939, page 204). The Tennessee specimen represents the first record of *uhleri*, as well as the genus *Helocordulia*, from that State.

Needham (1901) in his original description of *uhleri* states, "mental setae about 10 or 11, . . . lateral setae seven or six, when seven the basal one smaller than the others . . ." In the Handbook (1929, page 182), Needham gives 6 lateral setae as characteristic of *uhleri* and 7 setae for *selysii*. Kennedy (1924, pages 2 and 3) shows 6 lateral setae and 13 mental setae for *uhleri*. All of our specimens had 7 lateral setae and 12–14 mental setae, composed of 8 or 9 long lateral setae and 4 or 5 short medial setae. Needham (1901) describes the dorsal hook on segment "6 rudimentary, a mere low pointed tubercle." This is a confusing statement as in *uhleri* the dorsal hook of segment 6 is a definite spine-like structure. In our specimens, it is heavily set with denticles so as to somewhat obscure its shape, but viewed laterally it is definitely spine-like, and not a tubercle. Our specimens have the hook of segment 6 one-eighth or somewhat less the size of that of segment 7, and the dorsal hooks of segments 7 to 9 from one-half to as long as the segment bearing them. Lateral spines of segments 8 and 9 subequal, those of segment 9 reaching to or just beyond tips of superior appendage, but not to tips of inferiors. The nymph collected in Hardin County, Tennessee, was examined the same day found and showed the following interesting structural character: Ventral portion of distal margin of segment 9 with a row of large spine-like teeth and a series of very long hairs projecting outward in a fan-like fashion. The hairs are 1.5 to 2 mm. in length and far surpass the tips of the anal appendages. When the nymph was emersed in liquid, this structure was clearly visible. The hairs are easily destroyed after preservation of the nymph, but undoubtedly are typical of the species (and probably genus) as is indicated by remains of portions of the fan-shaped hair tuft in the specimens collected in 1938. In the Tennessee individual, a series of long hairs are present in some areas along the lateral margins of segment 9, but are missing in the greater part. All specimens examined by the writer have spine-like teeth on lateral margins of abdominal segments 2 to 9, increasing in size posteriorly; those on margins of segments 8 and 9 quite large and prominent, being 4 or 5 times the size of those on the proximal segments.

The male appendage, overlying the superior anal appendage, is rectangular in shape, covering about four-fifths of the superior appendage; the distal margin is truncate with rounded lateral angles.

Helocordulia selysii (Hagen)

The nymphal stage of this species has been very adequately described and illustrated by Kennedy (1924). As we have no specimens of *selysii* available for study, the important characters as discussed by Kennedy are given below:

Lateral setae 7; mental setae 13 or 14, composed of 8 very long lateral and 5 or 6 short medial setae. Dorsal hooks of segments 7 to 9 similar to those of *uhleri;* hooks of segment 6 a mere suggestion of a tubercle which was not visible (in exuviae) until the encrusting mud had been scraped away. Lateral spines of segment 8 about one-half the length of those of segment 9; spines of segment 9 more than one-half the length of segment 9, and reaching to tip of superior appendage.

In a letter to the writer dated February 11, 1938, Dr. C. H. Kennedy states, in answer to questions concerning the *Helocordulia selysii* nymph, "I have never felt uncertain of my identifica-

tion of my specimen and nymph taken at Raleigh. This specimen and skin are deposited in the National Museum in Washington so I am not able to study them further. However, before Williamson died he told me he felt very sure that the thing which I called *Helocordulia* was one of the southern species of *Tetragoneuria*. My memory is that he thought it was probably *petechialis*." I have not examined Kennedy's specimens of *selysii*, but, from the characters of the exuviae, it belongs without doubt to the genus *Helocordulia*. Our reasons for this statement are as follows: 1) its close similarity of the nymph of *uhleri*, found in New York by Needham (1901); 2) all of the known nymphs of *Tetragoneuria* and *Epicordulia* have dorsal hooks on segments 2 to 9, the lateral spines of segment 9 are as long or longer than the segment and reach or exceed the tips of the inferior anal appendages; and 3) the separation of the exuviae described by Kennedy from all other genera of *Cordulines* by characters given in the discussion of the generic groups listed in the beginning of this article. It is of interest to note that *Tetragoneuria petechialis* Muttkowski is very close to and often considered a variation of *T. stella* Williamson. The nymph of *petechialis* is unknown, but that of *stella* has been described by supposition and is typical of *Tetragoneuria* in having a complete set of dorsal hooks and long lateral spines on segment 9. There are no other dragonfly nymphs in our faunal area having the combination of characters possessed by *Helocordulia uhleri* and *selysii*.

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A NEW SPECIES OF CYCLOCOELUM (A TREMATODE) FROM THE EASTERN SOLITARY SANDPIPER

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Four specimens of the genus *Cyclocoelum* Brandes were found in the airsac of a solitary sandpiper, *Tringa solitaria solitaria*, by Walter Morrison at Lemont, at the foot of Mt. Nittany, near State College in 1939. They were given to Assistant Professor Merrill Wood, an ornithologist, who presented them to the author for identification and study.

The specimens were in excellent condition for making permanent mounts. They were slightly flattened between microscopic slides, and stained with Delafield's hematoxylin.

At least thirty species of *Cyclocoelum* with well differentiated characters have been described from birds, and are listed in the comparative tables of Bhalerao (1935) and Khan (1935). The species *C. dumetellae* from the catbird (Zeliff, 1943), *C. jaenschi* (Johnson and Simpson, 1940) from the airsac of grebes, in Australia, and *C. turusigi* (Yamaguti, 1939) from *Tringa* may be added. Ten of the species mentioned are from the genus *Tringa*. The specimens from the eastern solitary sandpiper do not check completely enough with those from the several species of *Tringa* nor other species of *Cyclocoelum*. They are herewith described as a new species.

Cyclocoelum nittanyense, n. sp.

Specific diagnosis: Body oblong, anterior third tapering slightly, the posterior fourth rounding slightly, both lateral surfaces with gradual convergence throughout, 10 to 11 mm. in length by 2 to 3 mm. in width; cuticle undulating and rough; oral sucker 0.27 mm. in diameter, subterminal and indistinctly outlined; acetabulum or ventral sucker lacking; pharynx 0.22 mm. in width by 0.24 mm. in length; prepharynx very short; esophagus 0.39 to 0.52 mm. in width by 0.82 mm. in length; intestinal ceca continuous in the posterior end, typical for the genus; excretory bladder between posterior intestinal arc and body wall; testes circular in outline, obliquely located, contiguous, 0.53 mm. to 0.90 mm. in diameter, approximately of equal size; vas deferens not observed; vasa efferentia not observed; cirrus sac terminating slightly behind anterior arc of intestinal bifurcation, 0.63 mm. in length by 0.21 mm. in width at seminal vesicle; seminal vesicle filling about two-thirds of cirrus sac; genital pore at posterior end of pharynx; ovary 0.16 mm. by 0.22 mm. in diameter, toward left lateral surface; seminal receptacle 0.21 mm. in diameter; Mehlis' gland 0.22 mm. in diameter; vitellaria extending from slightly cephalic of cirrus sac to posterior margin of posterior intestinal arc; transverse vitelline ducts, between testes and posterior testis and ovary; ootype and oviduct not observed; Laurer's canal not observed; ova 75 to 90 μ by 105 to 150 μ oval as viewed from above, but flattened and crescentic or pan-shaped from lateral view; receptaculum seminis uterinum present; uterine loops quite chevron-like, uterine wall not distinct in posterior portion.

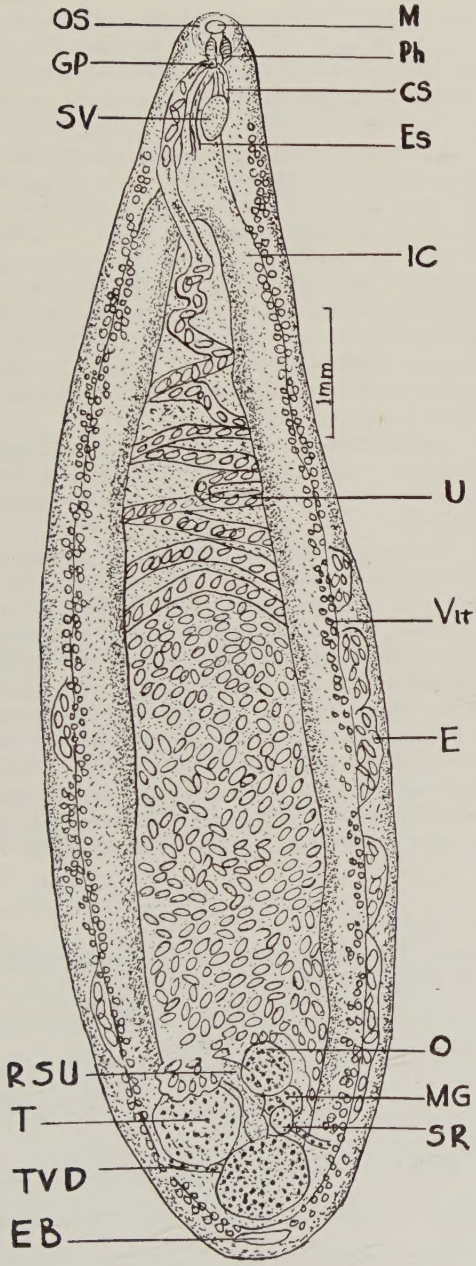
Host: *Tringa solitaria solitaria.*

Location: Airsac.

Locality: Lemont, Pa.

Type specimen: U. S. N. M. Helm. Coll. No. 36917 paratype also on same slide; two additional specimens in author's collection.

Remarks: The new species from the eastern solitary sandpiper is related to a group proposed by Khan (1935), with the ovary anterior to the testes, and a group in a section of the key made by Harrah (1922) with equal testes, not separated by uterine loops and with loops overlapping the ceca both dorsally and ventrally. Relationships to *C. taxorchis* (Johnson, 1917) of Australia of the first group are not close enough to make comparisons worth while. One of the four specimens has the testes reversed in position.



Explanation of Figure, ventral view:

CS—cirrus sac
E—egg
EB—excretory bladder
Es—esophagus
GP—genital pore
IC—intestinal cecum
M—mouth
MG—Mehlis' gland
U—uterus
O—ovary
OS—oral sucker
Ph—pharynx
RSU—receptaclum seminis uterinum
SR—seminal receptacle
SV—seminal vesicle
T—testis
TVD—transverse vitelline duct
Vit—vitellaria

FIG. 1. *Cyclocoelum nittanyense*, n. sp.

C. wilsoni (Harrah, 1922) from *Tringa* (*Glottis*) *wilsoni* of N. America and *C. triangularium* (Harrah, 1922) from *Tringa maculata* of N. America both have the testes at the same level rather than obliquely as the species from the eastern solitary sandpiper. The former also has unequal testes, genital pore at the middle of the pharynx, a shorter cirrus sac and less variable size of the eggs. The latter also has more constant size of the eggs and is of smaller size. The following three species have the testes in a position similar to the new species herein described but have the stated, several, major differences and minor differences, as do the previous two species.

Among the variations or differences of *C. halli* (Harrah, 1922), from *Tringa* (*Totanus*) *melanoleuca*, are the limitation of the vitellaria laterally to the ceca, size of eggs and location of the ovary toward the right lateral surface. The outstanding variations of *C. tringae* (Brandes, 1892) from *Tringa ocropus*, are the size, shorter cirrus sac, size of the eggs and unequal testes. In *C. brasilianum* (Stossich, 1903), from *Philomachus* (*Pavocella*) *pugnax*, *Tringa* (*Totanus*) *flavipes*, *Totanus melanoleuca*, and *Tringa solitaria* of S. America and in the next species the measurements of the bodies are the closest to this new species. The size of the eggs, shorter cirrus sac and the unequal testes are noticeable variations for this species from the new one. In *C. nebularium* (Khan, 1935) from *Tringa* (*Glottis*) *nebularia* from India these same variations occur. From *Tringa erythropus* of Japan, (Yamaguti, 1939) has described *C. turusigi*, which is not closely related. This last species differs from the species herein described by its much greater length, greater dimensions of the organs, location of the testes, and longer ova.

The host of *C. brasilianum* was given as *Scolopax flaviceps* and of *C. tringae* as *Tringa variabilis* by Stossich which names have been subject to rearranging. Khan (1935) lists more hosts for *C. brasilianum* than does its original describer, Stossich (1903). The western solitary sandpiper is now *Tringa solitaria cinnamonea* (Wilson).

According to Joyeux and Baer (1927) *C. triangularum* (Harrah, 1922) and *C. wilsoni* (Harrah, 1922) are synonyms of *C. taxorchis* (Johnson, 1917). Likewise *C. leidyi* (Harrah, 1922) and *C. problematicum* (Stossich, 1902) is a synonym of *C. obscurum* (Leidy, 1887). Also, *C. halli* (Harrah, 1922) is a synonym of *C. brasilianum* (Stossich, 1902). This would obviate comparing the new species with some of the above, assuming that these synonyms are generally acceptable.

Witenberg (1926) described *Cyclocoelum* (*Corpopyrum*) *kossacki* from *Evolia* (*Tringa*) *alpina* from Russia. This was later placed by Joyeux and Baer (1927) in *Cyclocoelum*. The species herein described differs from this species quite distinctly in size of the organs, especially the testes, and in sizes of the eggs. They are not very different in measurements of bodies. Since the eggs of most worms are quite uniform in shape and constant in size, or range in size; eggs would be expected to be a fairly reliable distinctive characteristic. *Cyclocoelum nittanyense* n. sp. does not match very closely any of the fourteen species listed by Joyeux and Baer (1927) in their table.

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